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ABSTRACT

This teacher's guide is designed to accompany the machine shop competency-based education curriculum for secondary students in West Virginia. It has been developed to facilitate use of the curriculum by instructors of machine shop programs. The teacher's guide contains the following material: an explanation of the curriculum and suggested usage; a list of competencies, by job title; job sheets; suggested tests; and a list of references to accompany the curriculum. The appendixes contain data and information on tasks currently performed and equipment used, as determined from a validation survey. There are also lists of additional tools and equipment used and tasks performed by respondents to the survey. The material is keyed to the 16 units of the student materials for the machine shop curriculum. Job titles covered by the competencies include machinist, electrical discharge machine set-up operator, numerical control machine operator, and machine shop supervisor (tool). (KC)

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ED201861

TEACHER'S GUIDE

for

COMPETENCY-BASED EDUCATION CURRICULUM

for

MACHINE SHOP

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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December 1980

CE 028 972

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PREFACE

This competency-based education (CBE) Machine Shop Curriculum was developed for West Virginia by Associated Educational Consultants, Inc., Pittsburgh, Pennsylvania, with the help of teachers of machine shop programs. The effort was coordinated by the staff of the Bureau of Vocational, Technical and Adult Education.

The Bureau began advocating CBE curriculum in 1974. Since that time, West Virginia has produced over twenty CBE curricula in various occupational areas. We also have a number of CBE curricula currently in the process of being developed and/or field-tested. This Machine Shop curriculum was disseminated to West Virginia teachers through workshops in the Spring of 1981. Additional copies of the curriculum are available from:

Vocational Curriculum Laboratory
Cedar Lakes Conference Center
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(304) 372-8673

I trust this curriculum will help your program. Any suggestions you may have for improving it may be sent to our State Curriculum Lab. Through this feedback we plan to continually update our materials.

VOCATIONAL, TECHNICAL AND ADULT EDUCATION



Clarence E. Burdette
Assistant State Superintendent of Schools

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ACKNOWLEDGMENTS

The planning, organizing, and coordinating of the development of this competency-based curriculum for machine shop required the working together of several people of specialized skills and abilities.

Associated Educational Associates, Inc. (AEC) relied heavily on the guidance of Mr. Kyle McGraw, formerly of the Bureau of Vocational, Technical and Adult Education and, particularly, Dr. Fred W. Harrington, Coordinator of Curriculum Development.

Several teachers of the machine shop programs in West Virginia provided assistance by submitting lists of references used in their programs as well as curriculum information.

We are especially indebted to Mr. Ronald Harrington, North Hills School District, Pittsburgh, Pennsylvania, who served not only as Content Consultant, but also as advisor and coordinator. Thanks are also due to Mr. James E. Litzinger, Central Westmoreland Area Vocational-Technical School, and Mr. Russell W. Busch, Coordinator of Apprentice Programs, Homestead Works, United States Steel Corporation.

A debt of gratitude is owed also to those many people who took time from their busy schedules to respond to the task validation survey: instructors of machine shop programs in West Virginia and Pennsylvania, and machinists and supervisors of machinists in both states.

TEACHER'S GUIDE

INTRODUCTION

This teacher's guide is designed to accompany the Machine Shop Competency-Based Education (CBE) Curriculum. It has been developed to facilitate use of the curriculum by instructors of Machine Shop programs.

The Teacher's Guide contains: an explanation of the curriculum and suggested usage; a list of competencies, by job title; job sheets; suggested tests; and a list of references to accompany the curriculum. The appendices contain data and information on tasks currently performed and equipment used, as determined from a validation survey. There are also lists of additional tools and equipment used and tasks performed by respondents to the survey.

The competency sheets and packets, or instructional modules, in the Student Material for Machine Shop may be used by either students or instructors, depending on your teaching style. Instructor Check Sheets in this book are to be used (1) by the student as a guide to standards to be attained, and (2) by the instructor to evaluate the student's performance.

In order to assure that tasks specified in the Machine Shop curriculum conformed with current practices in West Virginia and a neighboring labor market (Pennsylvania), a survey was conducted. People who work as machinists or as supervisors of machinists or as teachers in Machine Shop programs were surveyed to validate the lists of tasks and equipment. This curriculum, then, is built around the tasks which are actually performed by incumbent workers in the machining industry.

A copy of the data collected through the survey appears in this Teacher's Guide as Appendix A. You may find this data useful in working with your own advisory committee. The data are reported according to (1) state responses (West Virginia and Pennsylvania), (2) years of service in the occupation (1-5 years, 6-10 years, and more than 10 years), which can be helpful in determining entry level requirements, and (3) occupation of the respondent (machinist, supervisor, instructor). You will note that there are some differences between the responses of the various groups in regard to time spent performing a task. Time spent will vary according to labor market needs and position and should be of particular importance in your instructional planning.

You should also note that there are lists of additional tools and equipment, included as Appendix B, and additional tasks performed, included as Appendix C. These were noted by respondents in relation to invitations to list any tools or tasks not appearing on the survey. Be advised that some of these "tasks" may actually be steps which are a part of the Performance Checklists on the Student Competency Sheets of the curriculum; however, the respondents' statements are included as an appendix because the respondents felt they were important enough to list.

USES OF THE
MACHINE SHOP
COMPETENCY-BASED EDUCATION CURRICULUM

Curriculum Purpose

This competency-based education (CBE) curriculum, with Teacher's Guide, has been developed so that you may adapt any or all of its contents to accommodate your teaching style.

The purpose of this CBE curriculum is to provide you and your advisory committee with a set of West Virginia-validated Machine Shop tasks, along with (1) the Steps needed to perform each task, (2) the Evaluation Standards, and (3) suggested Learning Activities.

Depending on your teaching style, you may want to use this material primarily to assist you in your own teaching plans, or the material has been developed in enough detail so that it may, with proper supervision, be used by your students.

How you use this CBE curriculum is up to you. It has been based on the best Machine Shop information and material available in West Virginia and the United States.

Curriculum Design

The Student Competency Sheet (SCS) format has been designed for easy readability. The Unit, or unit of instruction, is noted at the top of each page, followed by a Module title (a group of related Tasks within a Unit), and an identifying Task statement (the name of the SCS). Each Task packet is keyed; for example, I-A-1, which indicates Unit I,

Module A, Task 1. Any subsequent related pages are keyed, in the upper right-hand corner, as ^{I-A-1}₂, ^{I-A-1}₃, ^{I-A-1}₄, etc.

The first major section of the SCS is a Performance Checklist, sometimes referred to as Performance Guide or "teaching steps." These are the steps necessary to accomplish performance of the stated Task. Learning Activities are geared toward enabling the student to perform each of the steps and to understand how and why they are done. Each Performance Checklist may be used by you as an evaluative aid. The Performance Checklist may be used as both a pre-test and a post-test for professional evaluation in relation to the Standard.

The mid-section of the SCS, the Test, is laid out to define the traditional performance objective in more easily identifiable terms. The "Test" has been divided into three (3) sections. The first, Items Needed, tells exactly what equipment, etc., must be collected to perform the task. You probably want to review these items to be sure that the listing is specific enough, that all are available in the classroom, and/or that there are not omissions of items required to perform the task according to local procedures. The second section, Task, is an itemized statement of just what the student must do to demonstrate accomplishment of the required skill. The third section, Standard indicates how well or to what degree the skill must be demonstrated. You have the option of modifying the standard to the degree that it meets local needs.

The last section of the SCS is Learning Activities, those learning experiences which will help the student to achieve competence in each

step of the Performance Checklist. Here are listed the recommended readings in books most commonly available in State programs. Where such readings are not included in the standard texts, other recommended sources are provided. If the recommended books are not available in your school, you should substitute similar materials. Likewise, where procedural learning activities can be added or substituted according to available resources or your experience with student needs, they should be freely added.

If you wish to supplement the SCS Learning Activities, the list of kinds of activities shown on the following page may be useful to you.

Learning Activities

Audio tape
Brainstorming
Bulletin board
Buzz groups
Chalk board

Committees
Community study
Computer
Debates
Demonstration

Discovery
Discussion
Displays
Dramatizations
Drill and practice

Exhibits
Field trips/research
Film loops
Films
Filmstrips

Flannel boards
Flipchart
Games
Graphics
Homework assignment

Illustrated talk
Independent study
Information sheets
Investigation/reporting
Laboratory work

Large-group/small-group instruction
Library research
Listening
Listing or diagramming
Models

Oral recitation
Panels/symposiums
Problem solving
Programmed materials
Projects

Question and answer
Reading out loud
Real objects
Resource persons
Review

Role playing
Simulation
Slides
Speaking
Step-by-step procedure panels

Supervised study
Team teaching
Television
Transparencies
Verbal illustrations

Videotape
Visual illustrations
Work-study
Writing

DEFINITION OF TERMS

COMPETENCY	A knowledge, skill, or judgment which the learner will demonstrate at a pre-determined level.
LEARNING ACTIVITIES	Activities and resources which will assist the learners in mastering the competencies. Learning activities can range from large group activities to small group activities to individual activities.
MODULE	(1) A group of related tasks within a unit. (2) An instructional packet consisting of Student Competency Sheet, Information Sheet(s) and/or Self-Check Test(s) and/or Performance Check Sheet(s) (rating sheets).
OCCUPATIONAL SURVEY	The procedure for collecting data to identify the duties and tasks that comprise one or more jobs, job types, or career field ladders, for the collection and analysis of information concerning such duties.
PERFORMANCE CHECKLIST/ PERFORMANCE GUIDE	A series of steps arranged in a sequence ordinarily followed which, when completed, may result in the performance of a task. Also called "teaching steps."
PERFORMANCE OBJECTIVE	(See also "Test.") A statement in precise, measurable terms of a particular behavior to be exhibited by a learner under specified conditions.
TASK	A unit of work activity which constitutes logical and necessary steps in the performance of a duty. A task has a definite beginning and ending point in its accomplishment and generally consists of two or more definite steps.
TASK ANALYSIS	The process of reviewing elements of a job for the purpose of improving training program content across program levels of vocational-technical education.

TEST

The measurement of a student's ability to perform all steps necessary to complete a task satisfactorily, as measured by instructor evaluation of pre-determined levels.

(1) Test, as identified on Student Competency Sheets, consists of elements which indicate the condition, or testing situation confronting the learner under specified conditions and the specific behavior expected.

"Test" is composed of three (3) parts:

Items Needed to perform the task, Task (what must be done to demonstrate competence), and Standard (how well, or to what standard, the skill must be demonstrated).

(2) A teacher-graded evaluation of the student's written demonstration of cognitive performance.

STANDARD

The specific level of performance or quality of product which is acceptable for an entry level skill; reflects a consensus from knowledgeable people in the occupation.

UNIT

A major segment of work comprising related tasks; one of the major activities involved in the work performed.

USE OF COMPETENCIES

BY

JOB TITLE

COMPETENCIES BY JOB TITLE

Upon satisfactory completion of the specified competencies, students will be prepared to work in the following occupations, as described in the Dictionary of Occupational Titles, 4th Edition. The lists of competencies, however, should be carefully reviewed with the local Craft Advisory Committee to assure compliance with local job market requirements.

Successful preparation for all occupations will include the following competencies:

1. Look for a job
2. Write a personal data sheet (resume)
3. Complete a job application form
4. Prepare for a job interview
5. Understand yourself
6. Understand successful work attitudes
7. Use principles of human relations
8. Maintain personal safety
9. Maintain general shop safety
10. Compute whole numbers
11. Compute common fractions
12. Compute decimal fractions
13. Calculate/express percentages, averages, and estimates
14. Use basic measuring tools
15. Dispose of scrap metal, chips or shavings, and trash or waste materials
16. Sweep and clean shop facility
17. Perform custodial tasks
18. Paint facilities
19. Inspect work area for safe working environment
20. Inspect work equipment for safe working environment
21. Hand sharpen cutting tools with abrasive stones
22. Inspect and repair hand tools
23. Store precision tools, cutters, fixtures, jigs or attachments
24. Install, level and fasten down machines
25. Inspect and remove, replace or adjust machine guards
26. Remove machine parts
27. Inspect and change drive pulleys or belts
28. Replace and adjust machine parts
29. Scrape and paint machines

COMPETENCIES BY JOB TITLE (Continued)

Group I

Machinist, D.O.T. Code 600.280-022

Sets up and operates machine tools and fits and assembles parts to make or repair metal parts, mechanisms, tools, or machines, applying knowledge of mechanics, shop mathematics, metal properties, and layout and machining procedures:

Studies specifications, such as blueprint, sketch, damaged part, or description of part to be replaced, to determine dimensions and tolerances of piece to be replaced, to determine dimensions and tolerances of piece to be machined, sequence of operations, and tools, materials, and machines required.

Measures, marks, and scribes dimensions and reference points to lay out stock for machining (Lay-Out Worker).

Sets up and operates metal-removing machines, such as lathe, milling machine, shaper, or grinder, to machine parts to specifications.

Verifies conformance of work piece to specifications, using measuring instruments (Tool Machine Set Up Operator).

Positions and secures work piece in holding device, such as chuck or collet, or on surplates and uses handtools, such as files, scrapers, and wrenches, to fit and assemble parts to assemblies or mechanisms.

Verifies dimensions and alignment with measuring instruments such as micrometers, height gauges, and gauge blocks.

May operate mechanism or machine, observe operation, or test with inspection equipment, to diagnose malfunction of machine or to test repaired machines.

May perform flame cutting and arc or gas welding operations, when required.

May develop specifications from general description and draw or sketch product to be made.

Other occupations listed in the Dictionary of Occupational Titles

Group 600 as Machinists and Related Occupations include those concerned with shaping metal parts by milling, turning, planing, abrading, boring, chipping, sawing, and shaving with a variety of metal-working

COMPETENCIES BY JOB TITLE (Continued)

machines. Duties include laying out, job setting, fitting, assembling, and repairing. Occupations primarily concerned with machining tools are included in Group 601 (constructing, repairing, maintaining, and calibrating machine shop tools, jigs and fixtures, instruments, and metal-forming dies) and with machining gears in Group 602 (shaping metal gears by any combination of milling, turning, planing, abrading, boring, chipping, sawing or shaving).

The Dictionary of Occupational Titles describes other Machine Trades Occupations within the following groupings:

Group 603 - Abrading Occupations: includes occupations concerned with smoothing, polishing, sharpening, or shaping metal objects by the wearing away action of abrasives or machine files.

Group 604 - Turning Occupations: includes occupations concerned with shaping metal by the paring or chipping action of rigid cutting tools applied to metal rotating in a lathe.

Group 605 - Milling, Shaping, and Planing Occupations: includes occupations concerned with shaping metal by the action of revolving, multiple-tooth cutters; rigid, single-edge cutters; or linear, single-pass, multiple-tooth cutters. Excess material is removed by milling, broaching, shaping, or planing, thus producing flat or profiled surfaces, grooves, splines, keyways, and slots. Includes shaping, without removal of excess material, by raising burrs, or by shaving strands from stock.

Group 606 - Boring Occupations: includes occupations concerned with piercing metal by means of rotary cutting tools advanced into the material in the direction of the tool's axis to make, enlarge, or thread holes.

Group 607 - Sawing Occupations: includes occupations concerned with severing or shaping metal by the reciprocal or rotary cutting action of a saw-toothed or abrasive-edged blade or disk which wears out a kerf.

COMPETENCIES BY JOB TITLE (Continued)

Due to variations in local employment opportunities and job requirements and related apprenticeship positions requiring machining skills, the following competencies should be reviewed in light of the Craft Committee's recommendations and the student's career goals:

General Operations:

1. Take micrometer readings
2. Use machining handbooks, charts, and tables to aid in mathematical calculations
3. Apply dimensions of parts from blueprints or specifications to job requirements
4. Convert to metric measurement
5. Calculate tolerances or allowances for proper fits
6. Measure stock
7. Calculate stock utilization in machine work
8. Calculate amount of material to be removed to obtain correct work limits
9. Determine material strength according to standard raw stock sizes
10. Test for hardness
11. Calculate conversion of revolutions per minute (RPM) to surface feet per minute (SFPM) for grinder application
12. Calculate machine speeds and feeds by formulas
13. Calculate change gearing for threading
14. Determine clearance, relief and rake of cutting tools
15. Calculate gear blank specifications for indexing
16. Interpret technical orders, standards, and specifications for machine work
17. Make sketches of parts to be machined
18. Perform layout for precision machine work using layout instruments
19. Select coolants, cutting oils or compounds for machine operation
20. Determine accuracy of precision measurement instruments with gauge blocks
21. Use depth gauges
22. Measure with height gauges
23. Measure with sine bar
24. Clamp work in holding device
25. Cut metal stock
26. Cut materials with hand hacksaws
27. Ream holes with hand reamers
28. Thread with hand taps
29. Thread with dies
30. Disassemble and assemble parts
31. Hone and lap surfaces
32. Remove damaged screws and other non-hardened threaded hardware
33. Remove and replace helical coil wire screw thread insert (STI)
34. Remove frozen or seized parts
35. Remove and install pins
36. Remove defective splines and replace with new splines

COMPETENCIES BY JOB TITLE (Continued)

Press Operation:

1. Inspect arbor presses for safe operational condition
2. Clean and lubricate arbor press
3. Clean hydraulic press
4. Select accessories and attachments for press work
5. Set up press and disassemble parts with presses
6. Set up press and assemble parts with presses
7. Set up, remove and replace parts with presses
8. Straighten miscellaneous parts with presses
9. Set up and punch materials with press
10. Set up and broach material with press

Drill Press Operation:

1. Inspect drill presses for safe operation condition
2. Perform preventive maintenance on drill press
3. Consider material of work piece to be drilled
4. Determine holding technique
5. Mount and secure work in holding device
6. Select tool or cutter for drill press operation
7. Sharpen drill using grinding wheel, freehand technique and using drill grinding jig
8. Secure tool or cutter in drill press spindle
9. Select sleeve to suit drill
10. Set drill press for proper feeds and speeds for operation performed
11. Center punch hole location
12. Drill hole to size
13. Countersink hole to drawing requirements
14. Drill hole to size
15. Countersink hole to drawing requirements
16. Counterbore to depth specified in blueprint
17. Spot-face work piece
18. Ream hole to size
19. Hand tap hole to blueprint specifications
20. Use tapping attachment to tap hole
21. Use automatic feed on drill press

Power Saw Operation:

1. Determine type of steel to be sawed
2. Select appropriate blades
3. Remove and replace saw blades
4. Select and set speeds and feeds for sawing operations
5. Cut and weld bandsaw blades to insert for contour sawing
6. Measure material and cut off material with power hacksaw
7. Saw with a metal bandsaw to scribed lines
8. Perform preventive maintenance on bandsaw
9. Perform preventive maintenance on power hacksaw

COMPETENCIES BY JOB TITLE (Continued)

Lathe Operation:

1. Set up engine lathe
2. Align lathe centers using approximate method
3. Align lathe centers using accurate measurement
4. Set up lathe for operations
5. Set up tool post grinder
6. Set up lathe and face work piece held in a chuck
7. Machine between centers on a lathe
8. Rough cut and finish cut with lathe
9. Using taper attachment, cut long external tapered surfaces
10. Using compound rest, cut short external tapered surfaces
11. Cut internal tapered surfaces
12. Perform contour, angular, or radii cuts with lathe
13. Perform lathe filing
14. Knurl parts with lathe
15. Perform grinding operation
16. Perform spinning operation using forming tool
17. Drill holes with lathe
18. Bore holes with lathe
19. Counterbore holes with lathe
20. Countersink holes using lathe
21. Ream holes with lathe
22. Die cut threads with lathe, hand threading
23. Die cut threads with lathe using die heads
24. Cut external threads with lathe
25. Cut internal threads with lathe
26. Tap threads with lathe - hand tap external threads
27. Rechase threads on lathe
28. Perform preventive maintenance on lathe
29. Inspect lathe for safe operation

Shaper Operation:

1. Align shaper attachment, work piece, and cutting tool
2. Select and set speeds and feeds of shapers
3. Select, shape, and sharpen cutting tools for shaper operation

Grinding Machine Operation:

1. Inspect grinding wheels
2. Balance grinding wheel
3. Dress and true grinding wheels
4. Attach and align materials for grinding operations
5. Set up grinder to run work piece between centers
6. Set up grinder to run on magnetic chuck - surface grinder
7. Select and set speeds and feeds of power feed grinders
8. Perform grinding machine operations as per set-up
9. Cut off or part materials with grinding machines
10. Polish with grinding machine
11. Measure, inspect, and rework work piece on grinding machines
12. Set up and perform surface grinding operations

COMPETENCIES BY JOB TITLE (Continued)

13. Set up, grind, and sharpen preshaped lathe tools - tool grinder
14. Set up grinder and sharpen plain milling cutters - universal grinder
15. Set up grinder and shape cold chisels - tool grinder
16. Set up abrasive belt grinder
17. Use abrasive belt grinder
18. Store grinding wheels
19. Perform preventive maintenance on grinder
20. Inspect grinder for safe operation

Milling Machine Operation:

1. Perform layout for precision machine work using milling machine
2. Align milling machine attachments
3. Align milling machine attachments - vertical milling attachments
4. Select and set speeds and feeds for milling work
5. Drill holes with milling machine
6. Bore holes with milling machines
7. Perform reaming operations
8. Bore to remove damaged bushing
9. Bore to finish bushing
10. Square metal using table vise
11. Square metal using dividing head
12. Mill an angle
13. Perform end milling
14. Perform straddle milling operations on the horizontal mill
15. Mill cylindrical work
16. Mill an external radius
17. Mill gears
18. Perform form milling
19. Perform cutting-off operations
20. Perform flycutting operations
21. Cut external keyway
22. Duplicate on the profile milling machine
23. Perform preventive maintenance on milling machine
24. Inspect milling machine for safe operation

Fabricating Operations:

1. Operate cylindrical grinder
2. Operate hone - cylinder hone
3. Perform bench filing
4. Polish metal
5. Heat treat metal
6. Fabricate special metalworking tools

COMPETENCIES BY JOB TITLE (Continued)

Group II

Metal Machining Occupations (Group 609 in the Dictionary of Occupational Titles) includes occupations not elsewhere classified which are concerned with shaping metal parts or products by removing excess material from stock or objects. Among these are Electrical Discharge Machine Set-Up Operator (D.O.T. Code 609.380-010) and Numerical Control Machine Operator (D.O.T. Code 609.662-010), to which the following competencies apply specifically:

1. Transfer drawing to tape
2. Turn with N/C machine
3. Mill with N/C machine
4. Drill with N/C machine
5. Set up (EDM) operation per drawing specifications

Group III

Machine Shop Supervisor, Tool, D.O.T. Code 600.121-010

Supervises and coordinates activities of workers engaged in custom-machining of metal work pieces to produce, maintain, or repair parts for machines, molds, and equipment, applying knowledge of machine shop procedures, variety of machine tool set and operating techniques, metal and plastic properties, and custom-machining methods.

May supervise workers in related processes, such as metal forming, welding, or assembly.

Performs duties as described under Supervisor.

Depending upon their proficiency in performing machining tasks and upon their career goals, some students aspire to eventual supervisory positions. Also, some instructors may prefer to include the following tasks in the program of study to familiarize students with supervisory

COMPETENCIES BY JOB TITLE (Continued)

responsibilities in order to facilitate supervisor-employee understanding:

1. Inventory supplies and materials
2. Order and receive stock
3. Supervise maintenance of shop safety equipment, safe operations, and set-up of machinery
4. Supervise machine use and operation
5. Conduct follow-up on product quality control standards

MACHINE SHOP CURRICULUM

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MACHINE SHOP CURRICULUM

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UNIT MODULE TASK

A. Employment Opportunities

1. Look for a job
2. Write a personal data sheet (resume)
3. Complete a job application form
4. Prepare for a job interview

B. Human Relations

1. Understand yourself
2. Understand successful work attitudes
3. Use principles of human relations

C. Safety

1. Maintain personal safety
2. Maintain general shop safety

D. Basic Mathematics

1. Compute whole numbers
2. Compute common fractions
3. Compute decimal fractions
4. Calculate/express percentages, averages, and estimates
5. Use basic measuring tools

I. Maintaining Shop Facilities and Work Areas

A. Clean Up

1. Dispose of scrap metal, chips or shavings, and trash or waste materials
2. Sweep and clean shop facility

B. Maintenance

1. Perform custodial tasks
2. Paint facilities

C. Safety

1. Inspect work area for safe working environment
2. Inspect work equipment for safe working environment

UNIT MODULE TASK

II. Performing Mathematical Calculations

A. Measurement

1. Take micrometer readings
2. Use machining handbooks, charts, and tables to aid in mathematical calculations
3. Apply dimensions of parts from blueprints or specifications to job requirements
4. Convert to metric measurement
5. Calculate tolerances or allowances for proper fits
6. Measure stock

B. Calculating Materials

1. Calculate stock utilization in machine work
2. Calculate amount of material to be removed to obtain correct work limits
3. Determine material strength according to standard raw stock sizes
4. Test for hardness

C. Calculating Speed

1. Calculate conversion of revolutions per minute (RPM) to surface feet per minute (SFPM) for grinder application
2. Calculate machine speeds and feeds by formulas
3. Calculate change gearing for threading

D. Calculating for Machine Set-Up

1. Determine clearance, relief and rake of cutting tools
2. Calculate gear blank specifications for indexing

III. Performing Bench Work

A. Sharpening Tools

1. Hand sharpen cutting tools with abrasive stones

B. Cutting and Reaming

1. Cut materials with hand hacksaws
2. Ream holes with hand reamers
3. Thread with hand taps
4. Thread with dies

UNIT MODULE TASK

C. Assembly

1. Disassemble and assemble parts
2. Hone and lap surfaces
3. Remove damaged screws and other non-hardened threaded hardware
4. Remove and replace helical coil wire screw thread insert (STI)
5. Remove frozen or seized parts
6. Remove and install pins
7. Remove defective splines and replace with new splines

IV. Operating Presses

A. Maintenance and Inspection

1. Inspect arbor presses for safe operational condition
2. Clean and lubricate arbor press
3. Clean hydraulic press
4. Select accessories and attachments for press work

B. Setting Up

1. Set up press and disassemble parts with presses
2. Set up press and assemble parts with presses
3. Set up, remove and replace parts with presses
4. Straighten miscellaneous parts with presses
5. Set up and punch materials with press
6. Set up and broach material with press

V. Operating Drill Presses

A. Drill Press Maintenance

1. Inspect drill presses for safe operational condition
2. Perform preventive maintenance on drill press

B. Setting Up for Drilling

1. Consider material of work piece to be drilled
2. Determine holding technique
3. Mount and secure work in holding device
4. Select tool or cutter for drill press operation
5. Sharpen drill using grinding wheel, freehand technique and using drill grinding jig
6. Secure tool or cutter in drill press spindle
7. Select sleeve to suit drill
8. Set drill press for proper feeds and speeds for operation performed
9. Center punch hole location

UNIT MODULE TASK

C. Drilling

1. Drill hole to size
2. Countersink hole to drawing requirements
3. Counterbore to depth specified in blueprint
4. Spot-face work piece
5. Ream hole to size
6. Hand tap hole to blueprint specifications
7. Use tapping attachment to tap hole
8. Use automatic feed on drill press

VI. Operating Power Saws

A. Setting Up

1. Determine type of steel to be sawed
2. Select appropriate blades
3. Remove and replace saw blades
4. Select and set speeds and feeds for sawing operations
5. Cut and weld bandsaw blades to insert for contour sawing

B. Cutting

1. Measure material and cut off material with power hacksaw
2. Saw with a metal bandsaw to scribed lines

C. Saw Maintenance

1. Perform preventive maintenance on bandsaw
2. Perform preventive maintenance on power hacksaw

VII. Operating Lathes

A. Setting Up

1. Set up engine lathe
2. Align lathe centers using approximate method
3. Align lathe centers using accurate measurement
4. Set up turret lathe for operations
5. Set up tool post grinder

B. Cutting

1. Set up lathe and face work piece held in a chuck
2. Machine between centers on a lathe
3. Rough cut and finish cut with lathe
4. Using taper attachment, cut long external tapered surfaces

UNIT MODULE TASK

5. Using compound rest, cut short external tapered surfaces
6. Cut internal tapered surfaces
7. Perform contour, angular, or radii cuts with lathe

C. Finishing Operation

1. Perform lathe filing
2. Knurl parts with lathe
3. Perform grinding operation
4. Perform spinning operation using forming tool

D. Boring and Drilling Operation

1. Drill holes with lathe
2. Bore holes with lathe
3. Counterbore holes with lathe
4. Countersink holes using lathe
5. Ream holes with lathe

E. Threading

1. Die cut threads with lathe, hand threading
2. Die cut threads with lathe using die heads
3. Cut external threads with lathe
4. Cut internal threads with lathe
5. Tap threads with lathe - hand tap internal threads
6. Rechase threads on lathe

F. Lathe Maintenance

1. Perform preventive maintenance on lathe
2. Inspect lathe for safe operation

VIII. Operating Shapers

A. Setting Up

1. Align shaper attachment, work piece, and cutting tool
2. Select and set speeds and feeds of shapers
3. Select, shape, and sharpen cutting tools for shaper operation

B. Cutting Operation

1. Surfacing
2. Mill slots and keyways

C. Maintenance

1. Performing preventive maintenance
2. Inspect for safe operation

UNIT MODULE TASK

IX. Operating Grinding Machines

A. Setting Up for Grinding

1. Inspect grinding wheels
2. Balance grinding wheels
3. Dress and true grinding wheel
4. Attach and align materials for grinding operations
5. Set up grinder to run work piece between centers
6. Set up grinder to run on magnetic chuck - surface grinder
7. Select and set speeds and feeds of power feed grinders

B. Grinding Operations

1. Perform grinding machine operations as per set-up
2. Cut off or part materials with grinding machines
3. Polish with grinding machine
4. Measure, inspect, and rework work piece on grinding machines
5. Set up and perform surface grinding operations
6. Set up, grind, and sharpen preshaped lathe tools - tool grinder
7. Set up grinder and sharpen plain milling cutters - universal grinder
8. Set up grinder and shape cold chisels - tool grinder

C. Using Abrasive Belt Grinder

1. Set up abrasive belt grinder
2. Use abrasive belt grinder

D. Grinding Equipment Maintenance

1. Store grinding wheels
2. Perform preventive maintenance on grinder
3. Inspect grinder for safe operation

X. Operating Milling Machines

A. Setting Up

1. Align milling machine attachments
2. Align milling machine attachments - vertical milling attachments
3. Select and set speeds and feeds for milling work

B. Boring and Drilling

1. Drill holes with milling machine
2. Bore holes with milling machines
3. Perform reaming operations
4. Bore to remove damaged bushing
5. Bore to finish bushing

UNIT MODULE TASK

C. Milling

1. Square metal using table vise
2. Square metal using dividing head
3. Mill an angle
4. Perform end milling
5. Perform straddle milling operations on the horizontal mill
6. Mill cylindrical work
7. Mill an external radius
8. Mill gears
9. Perform form milling
10. Perform cutting-off operations
11. Perform flycutting operations
12. Cut external keyway
13. Duplicate on the profile milling machine

D. Milling Machine Maintenance

1. Perform preventive maintenance on milling machine
2. Inspect milling machine for safe operation

XI. Performing Metalwork Operations

A. Measuring

1. Determine accuracy of precision measurement instruments with gauge blocks
2. Use depth gauges
3. Measure with height gauges
4. Measure with sine bar

B. Setting Up

1. Clamp work in holding device
2. Cut metal stock

C. Performing Fabrication Operations

1. Operate cylindrical grinder
2. Operate hone - cylinder hone
3. Perform bench filing
4. Polish metal
5. Heat treat metal
6. Fabricate special metalworking tools

UNIT MODULE TASK

XII. Designing and Planning Machine Work

A. Design

1. Interpret technical orders, standards, and specifications for machine work
2. Make sketches of parts to be machined
3. Perform layout for precision machine work using layout instruments
4. Perform layout for precision machine work using milling machine

XIII. Performing Supervisory Functions

A. Maintaining Supplies and Materials

1. Inventory supplies and materials
2. Order and receive stock

B. Supervising Safety and Operations

1. Supervise maintenance of shop safety equipment, safe operations, and set-up of machinery
2. Supervise machine use and operation

C. Maintaining Quality Control

1. Conduct follow-up on product quality control standards

XIV. Maintaining Machines and Tools

A. Cleaning and Storing Tools

1. Inspect and repair hand tools
2. Clean and store hand tools, cutters, fixtures, jigs or attachments
3. Store precision tools

B. Maintaining Machines

1. Install, level and fasten down machines
2. Inspect and remove, replace or adjust machine guards
3. Remove machine parts
4. Inspect and change drive pulleys or belts
5. Replace and adjust machine parts
6. Select coolants, cutting oils or compounds for machine operation
7. Scrape and paint machines

UNIT MODULE TASK

XV. Performing Production Machinist Line Work

A. Numerical Control (N/C)

1. Transfer drawing to tape
2. Turn with N/C machine
3. Mill with N/C machine
4. Drill with N/C machine

B. Electrical Discharge Machine (EDM)

1. Set up operation per drawing specifications

JOB SHEETS

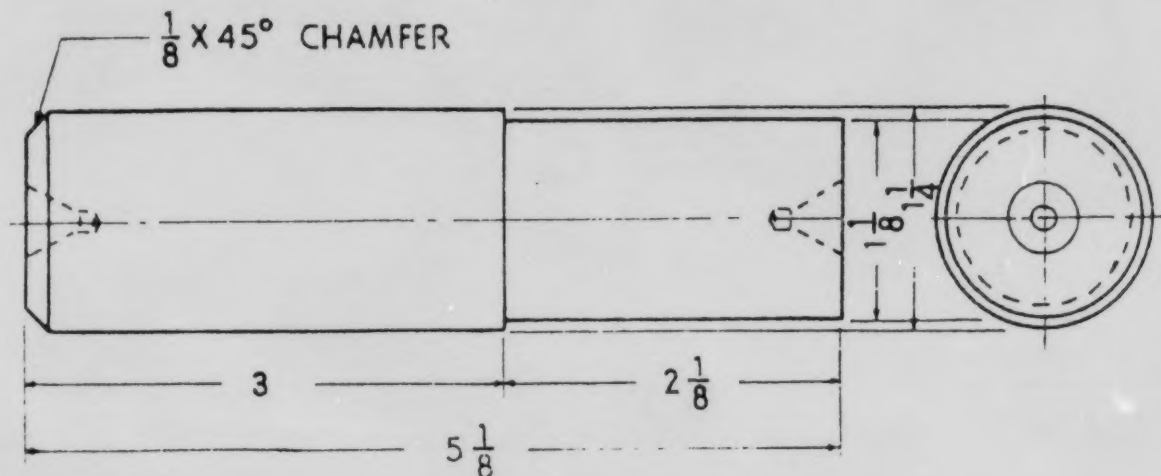
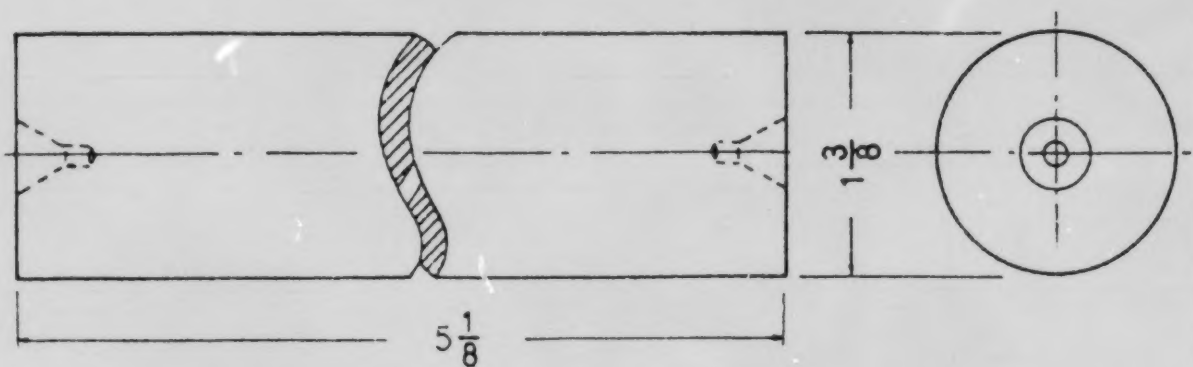
JOB SHEETS

The job sheets in this section were prepared for the Machine Shop Job Sheet Series (West Virginia State Board of Vocational Education, Division of Vocational Education, Trade and Industrial Education Service, n.d.). They may be used in conjunction with this curriculum. Another suggested reference is the Trade and Industrial Education Course of Study for Machine Shop Practice (Robert J. Emerly, M. William Golder, Charles R. Skovira, eds., The Pennsylvania State University, College of Education, Department of Vocational Education and Pennsylvania Department of Education, Bureau of Vocational Education, 1973). This publication includes operation sheets and equipment and tools, safety precautions, and procedures for the following job sheets:

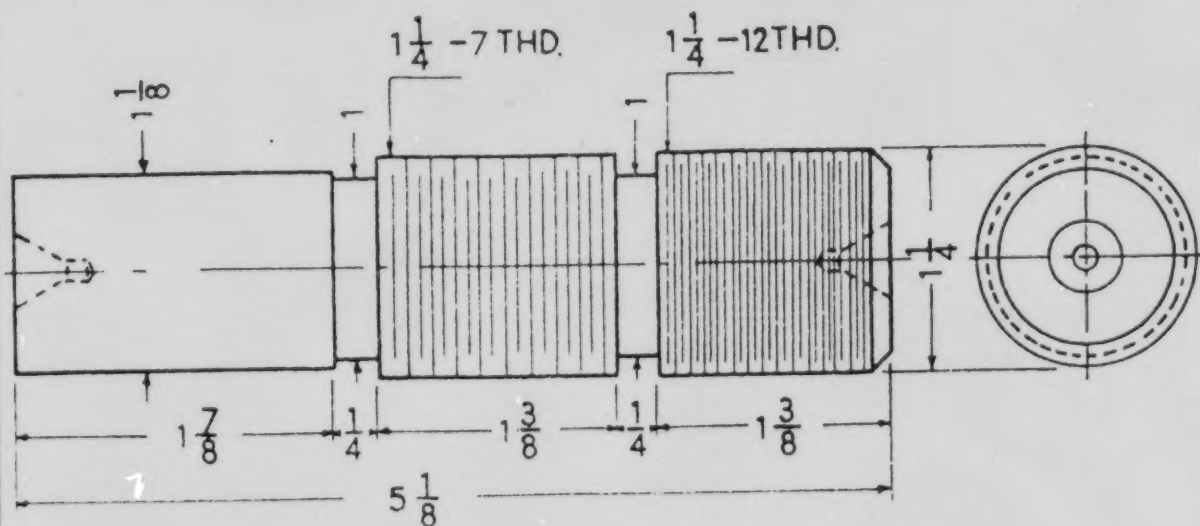
Drill Drift	Meat Tenderizer - Head
Tool Post Wrench	Meat Tenderizer - Handle
Cross Peen Hammer	Lathe Centers
Idler Shaft	Scriber - Nose
Stud Bolt	Scriber - Plug
Can Punch	Scriber - Point
Depth Gauge - Base	Scriber - Body
Depth Gauge - Handle	Plumb Bob
Depth Gauge - Screw	Paper Punch - Body
Depth Gauge - Rod	Paper Punch - Base
C-Clamp - Body	Paper Punch - Punch
C-Clamp - Screw	Paper Punch - Cap
C-Clamp - Screw Cap	Assembly of Paper Punch
Drill Grinding Gauge	Center Finder - Cap
Parallel Clamp - Threaded Jaw	Center Finder - Ball
Parallel Clamp - Loose Jaw	Center Finder - Point
Parallel Clamp - Straight Clip	Center Finder - Insert
Parallel Clamp - Adjusting Screw	Center Finder - Shank
Parallel Clamp - Clamping Screw	Wheel Puller - Yoke
Tap Wrench - Handles	Wheel Puller - Legs
Tap Wrench - Thumb Screws	Wheel Puller - Screw
Punch Set	Wheel Puller - Knobs
Cold Chisel	Wheel Puller - Handle
Ball Peen Hammer - Head	Wheel Puller - Leg Screws
Ball Peen Hammer - Handle	Wheel Puller - Point
Ball Peen Hammer - Handle Plug	Toolmakers Vise - Body
Jack Screw - Base	Toolmakers Vise - Movable Jaw
Jack Screw - Sleeve	Toolmakers Vise - Sliding Plate
Jack Screw - Screw	Toolmakers Vise - Screw
Jack Screw - Swivel	Toolmakers Vise - Hardened Jaws

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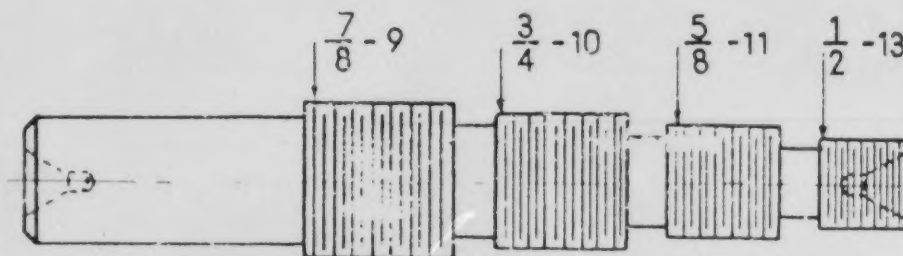
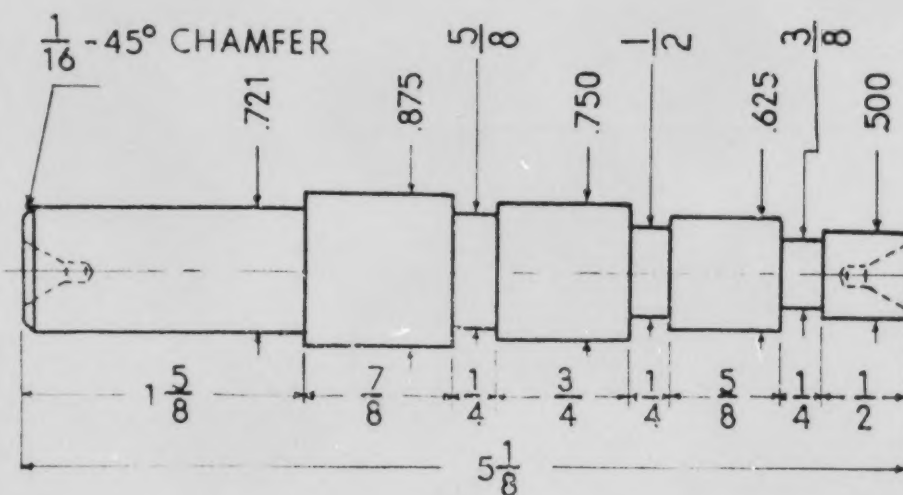
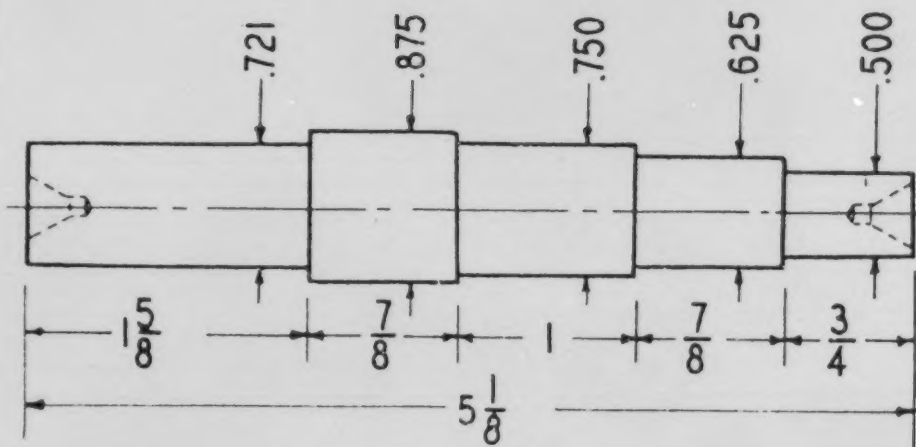
Idler Shaft



Threading Practice



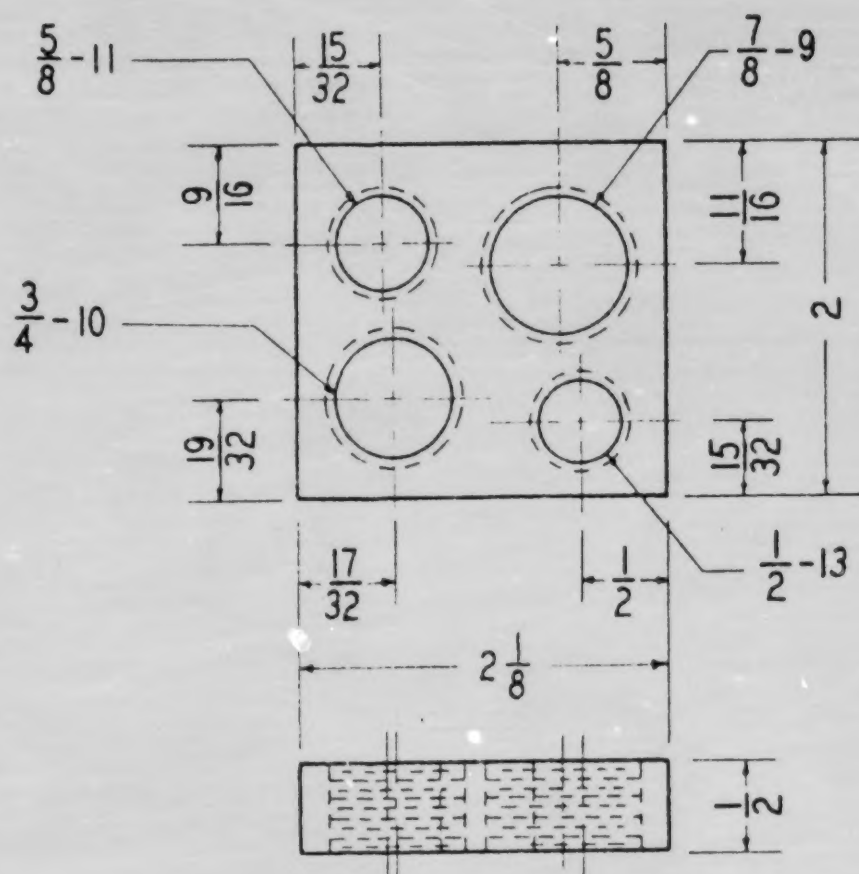
Threading Practice



Machine Shop Job Sheet Series

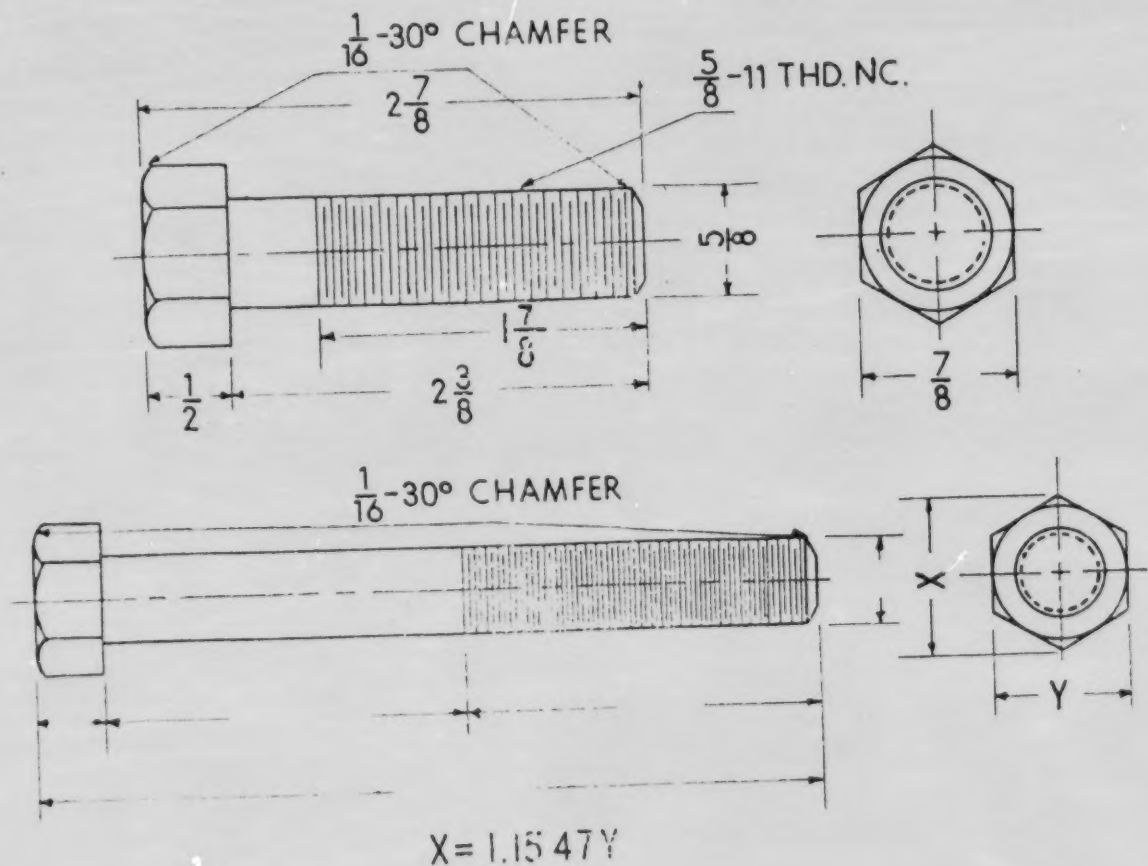
Job No. 3

Tapping Practice



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Hex Head Bolts



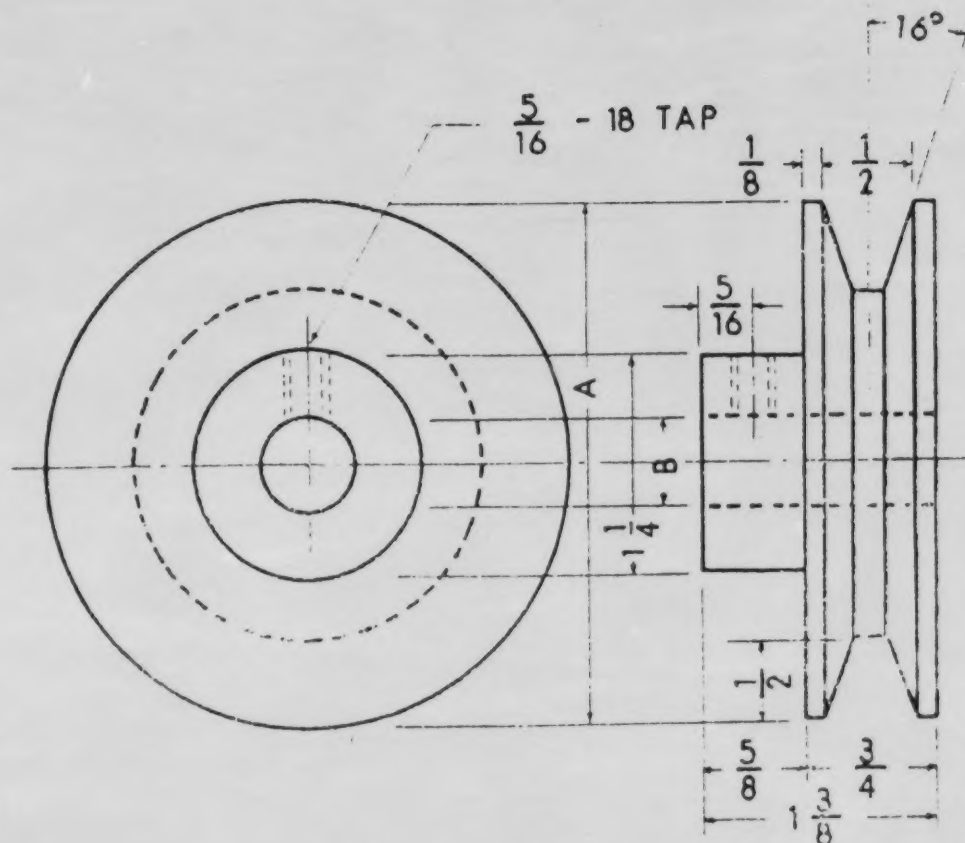
Machine Shop Job Sheet Series

Job No. 5

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Pulley

	1	2	3
A	3	$2\frac{1}{2}$	2
B	$\frac{5}{8}$	$\frac{1}{2}$	$\frac{1}{2}$



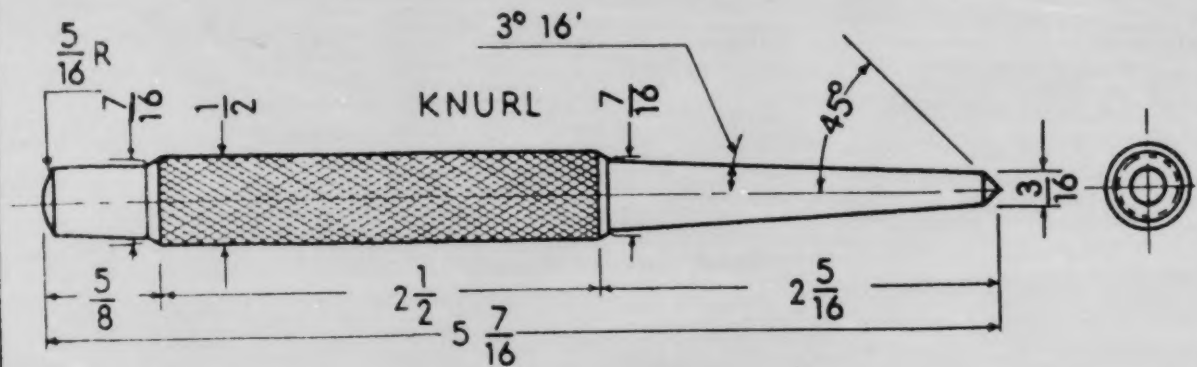
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Machine Shop Job Sheet Series

Job No. 6

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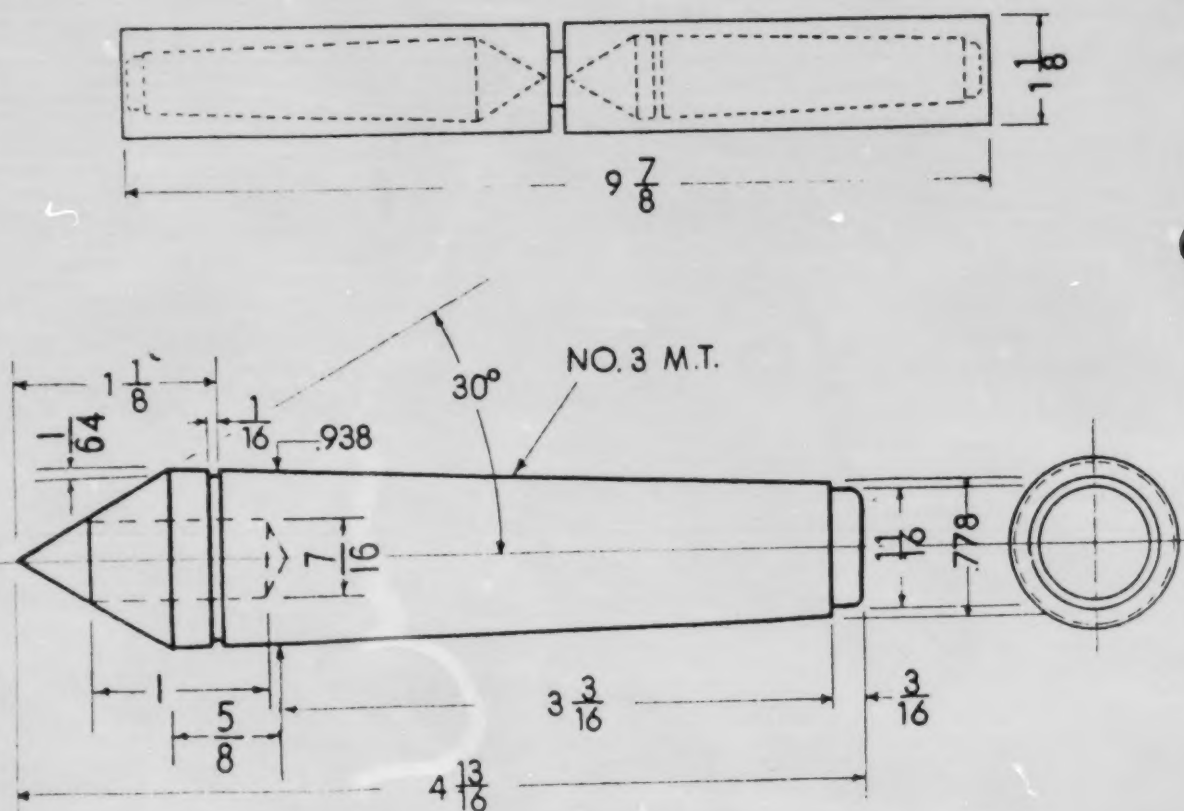
Center Punch



Machine Shop Job Sheet Series

Job No. 7

Lathe Centers



45

Parallel Clamp Screws

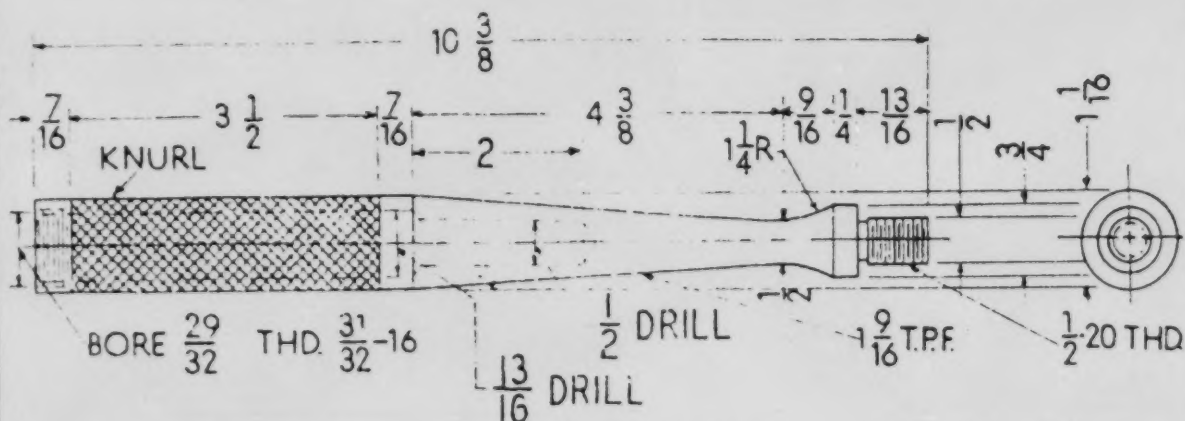


Job No. 9

Tap Wrench



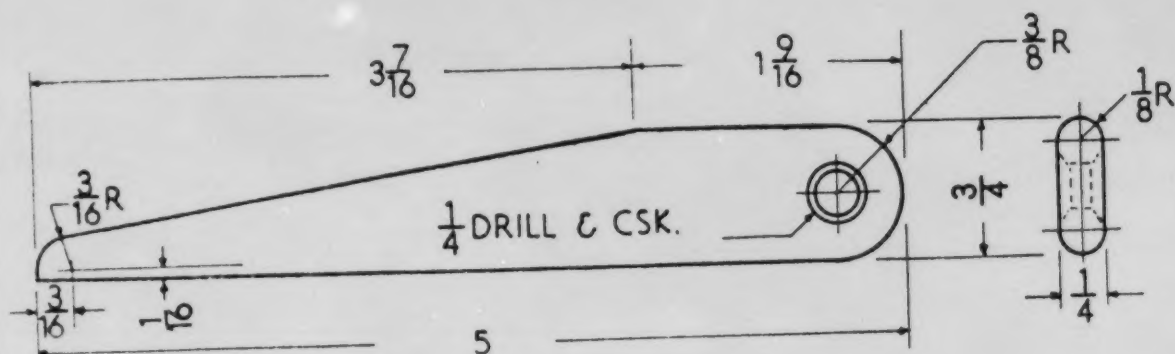
Machinists Hammer



Job No. 11

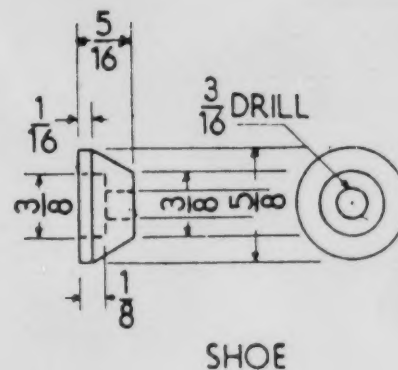
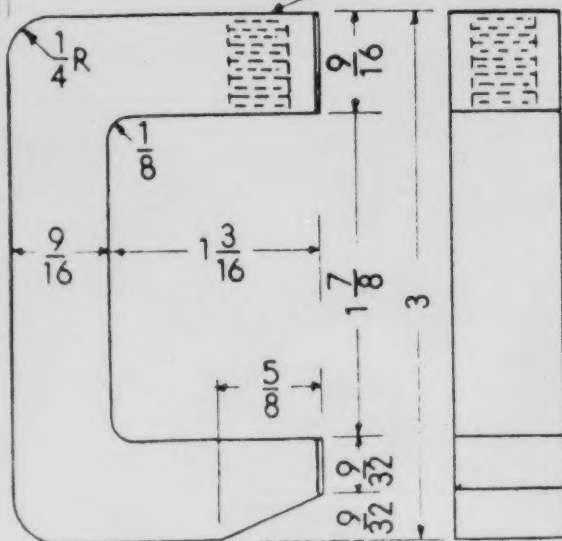
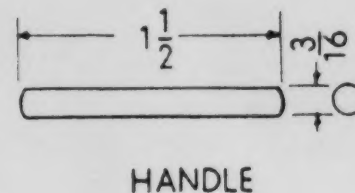
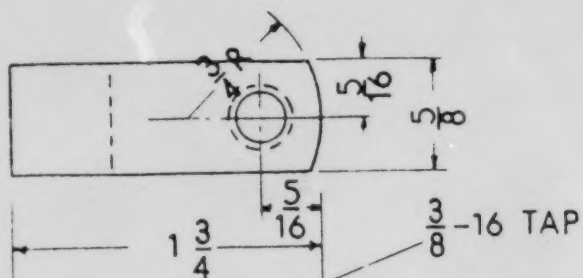
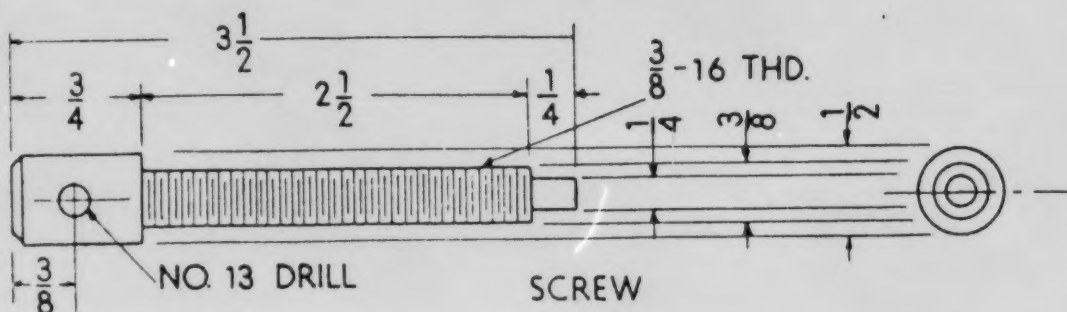
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Drill Drift



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C-Clamp

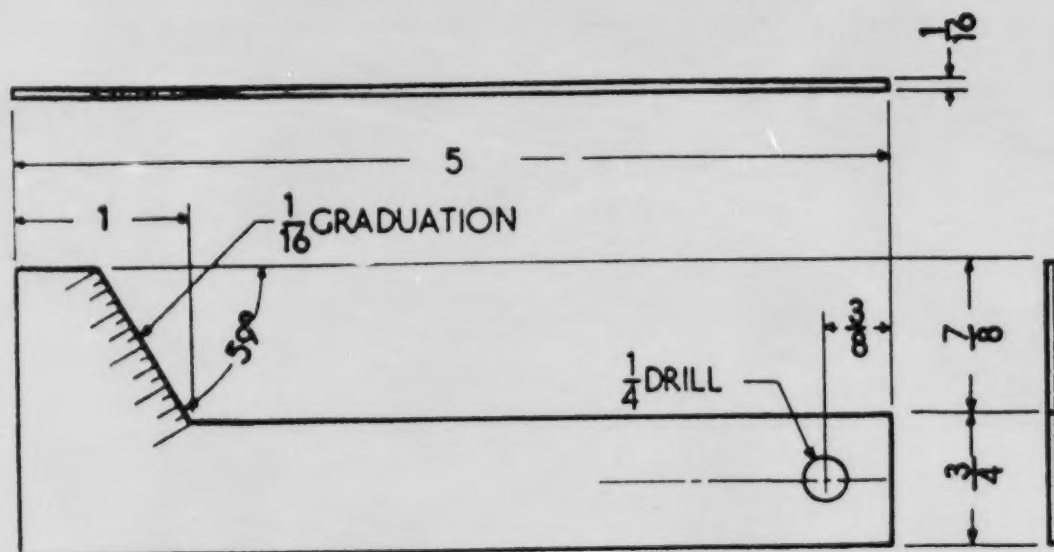


Machine Shop Job Sheet Series

Job No. 13

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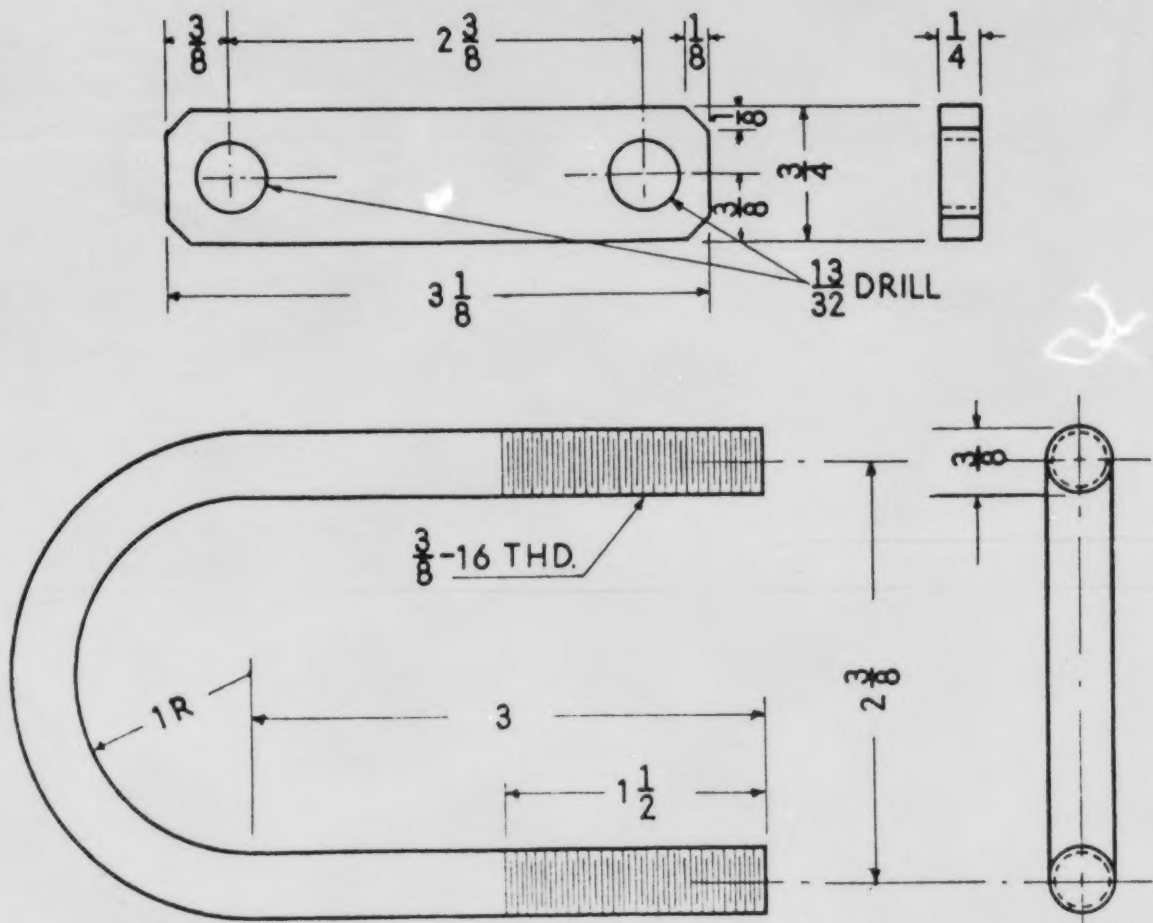
Drill Grinding Gauge



Job No. 14

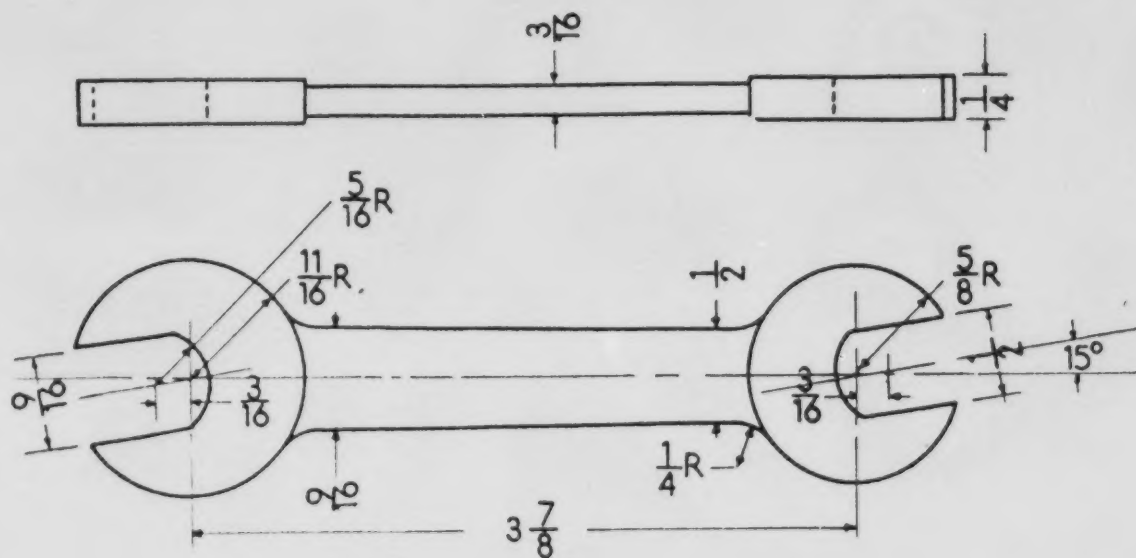
WEST VIRGINIA

U-Bolt

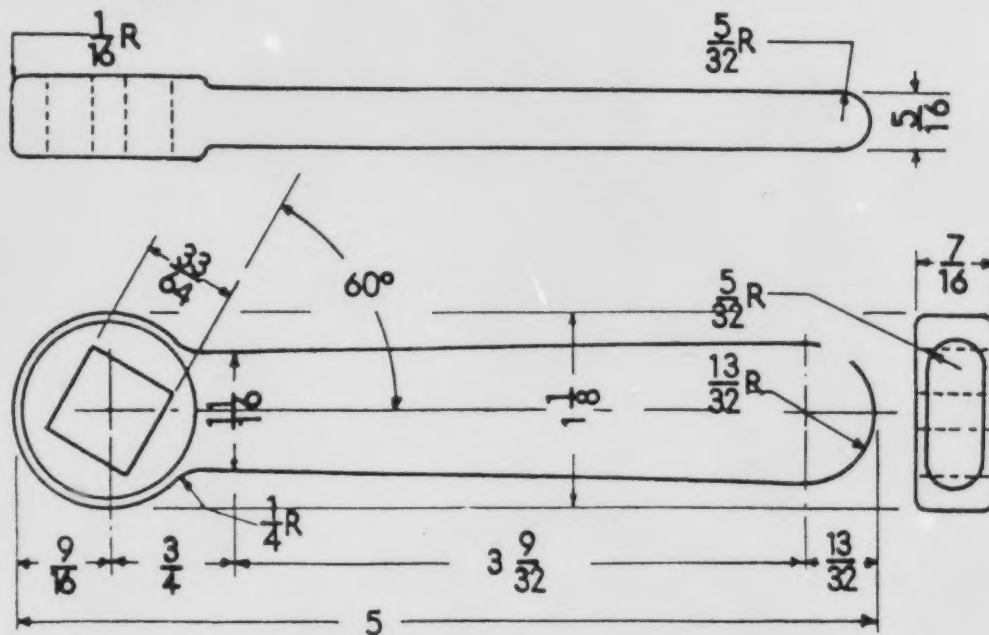


Job No. 15

Open End Wrench

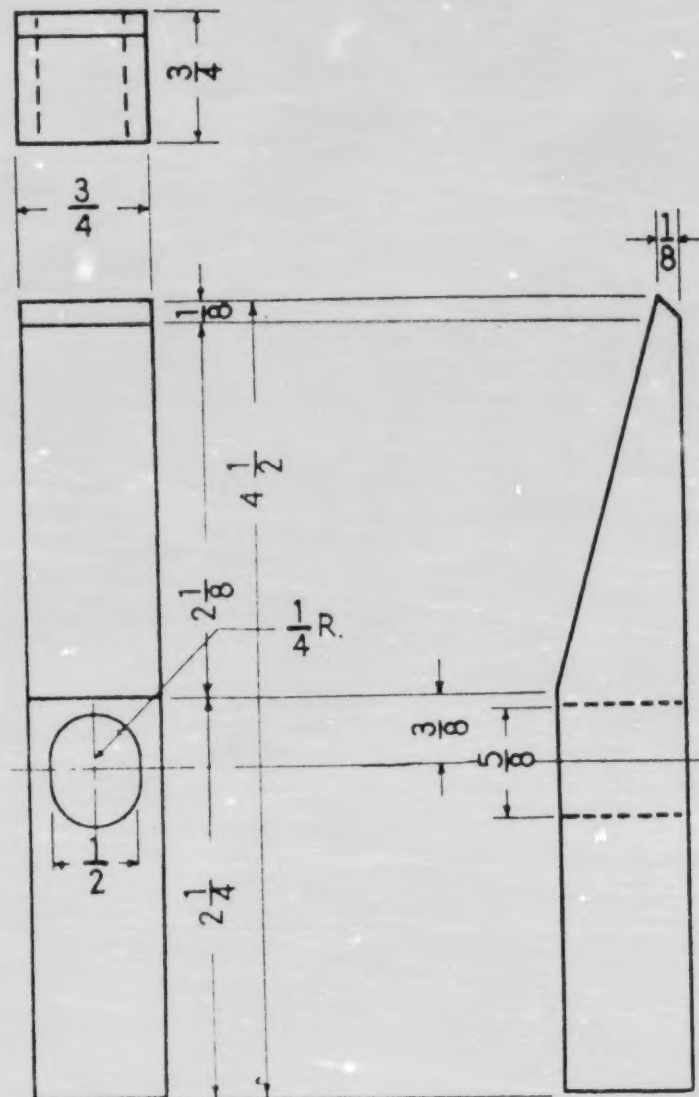


Lathe Tool Post Wrench



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Setting Hammer

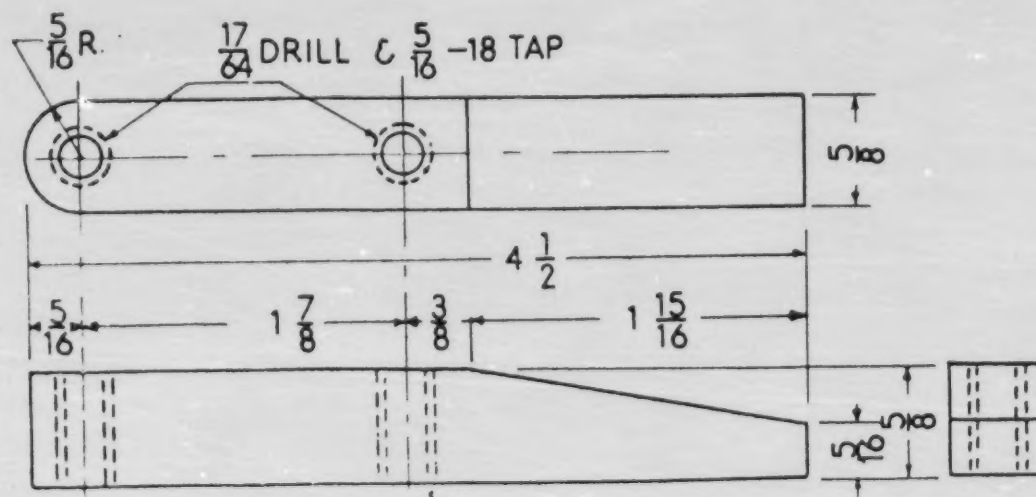
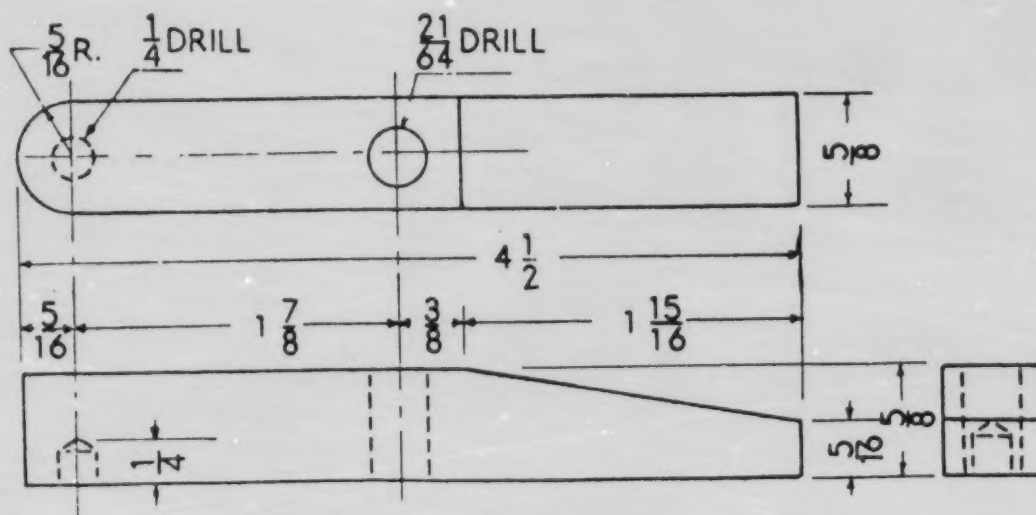


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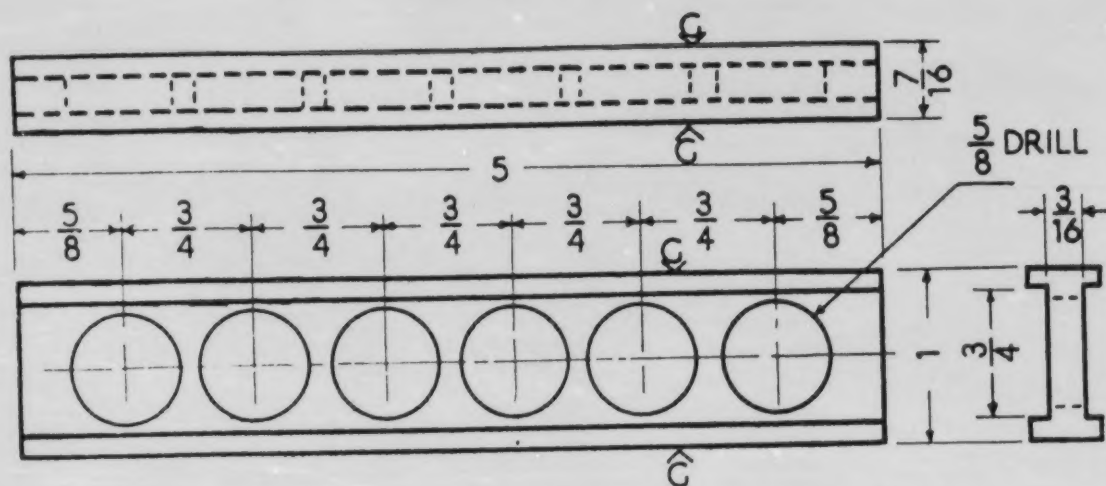
Machine Shop Job Sheet Series

Job No. 18

Parallel Clamp Bars



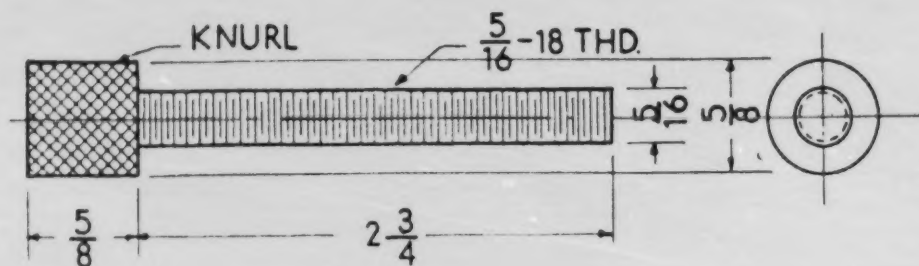
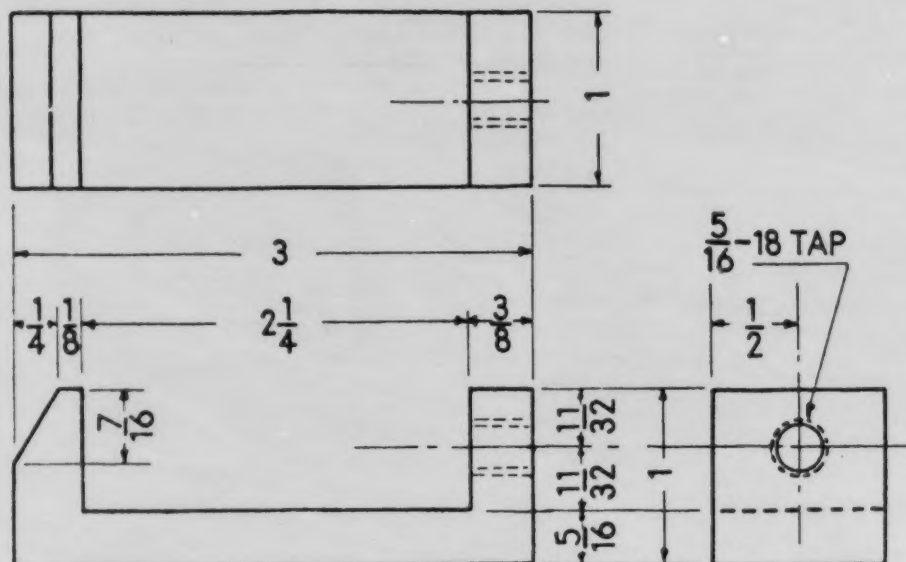
Parallels



Job No. 20

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Tool Makers Vise

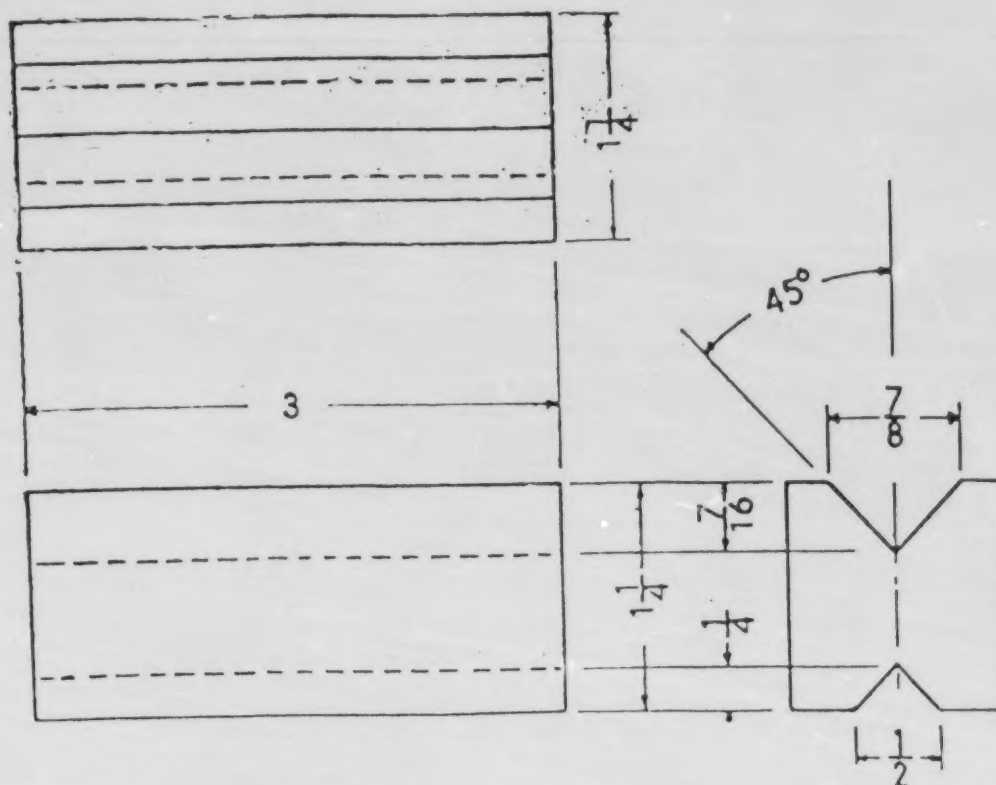


Machine Shop Job Sheet Series

Job No. 21

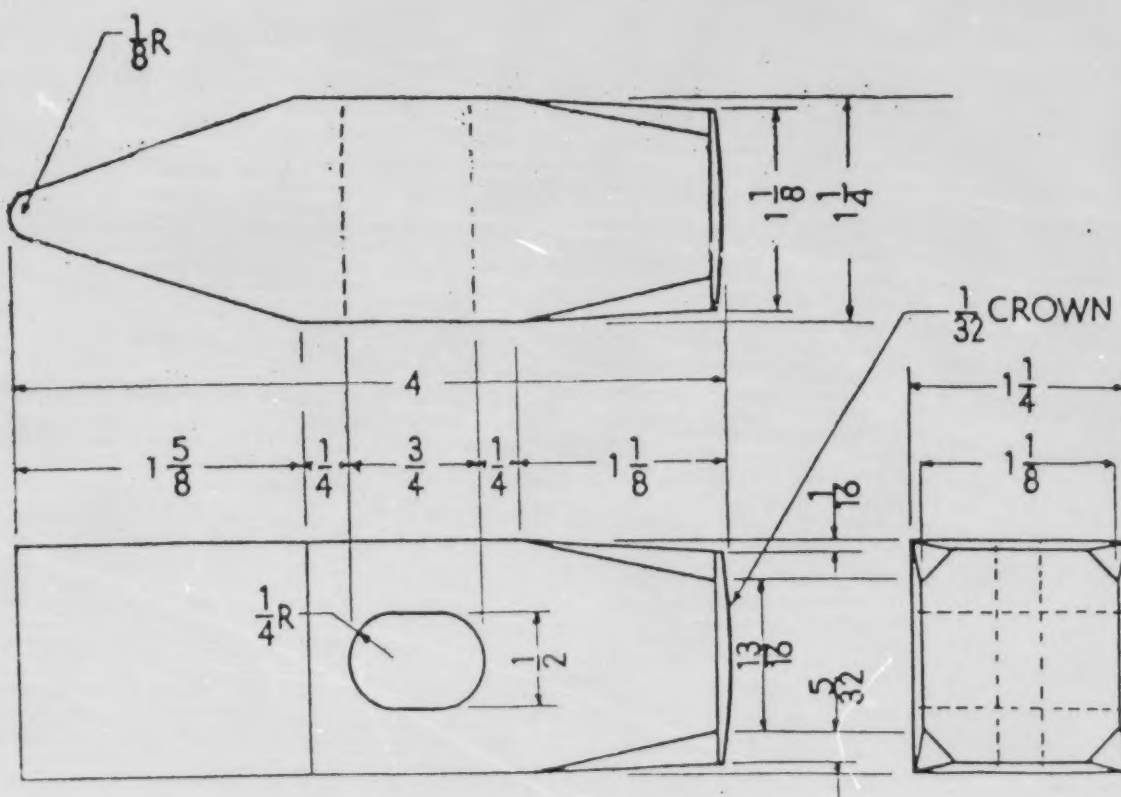
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V-Block



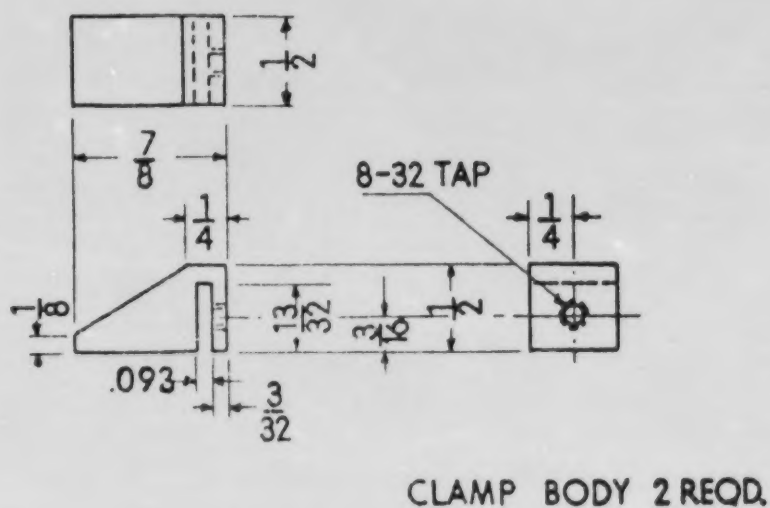
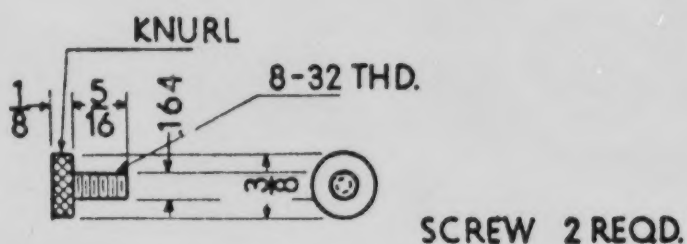
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Cross Peen Hammer



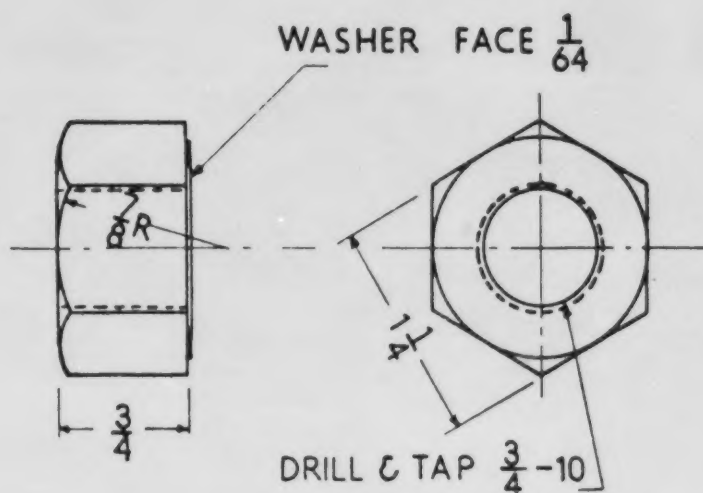
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Key Seat Clamps



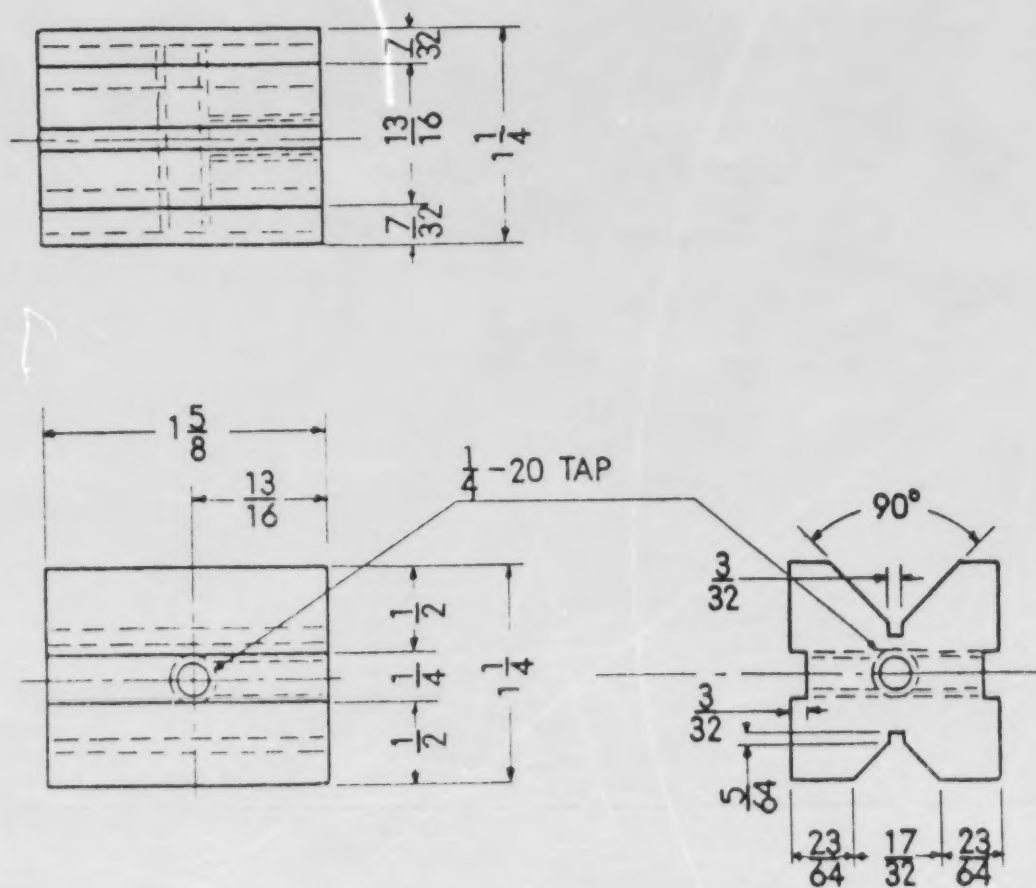
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Hex Nut



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V-Block



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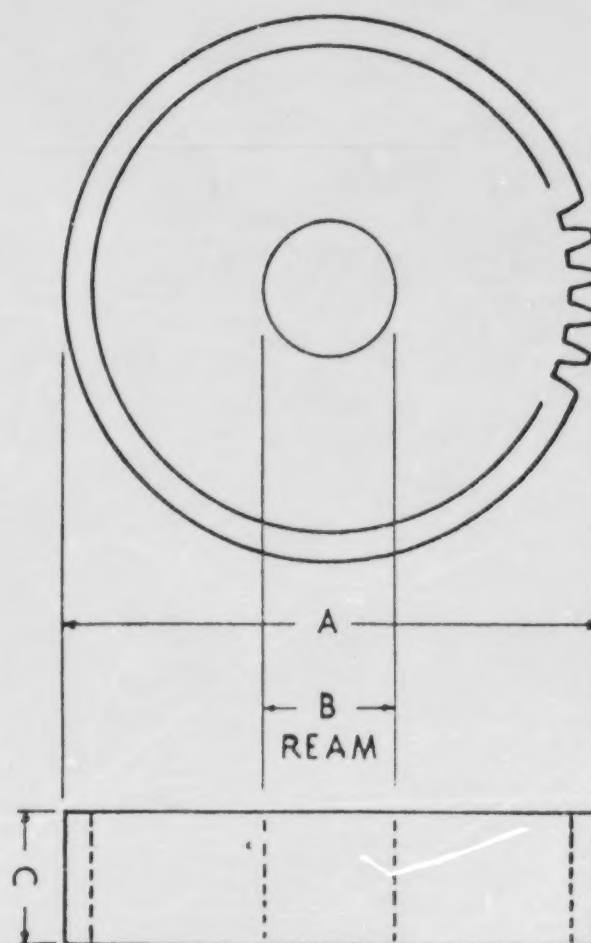
Machine Shop Job Sheet Series

Job No. 26

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Spur Gear

	A	B	C
1	3	$\frac{3}{4}$	$\frac{3}{4}$
2	2	$\frac{1}{2}$	$\frac{5}{8}$
3	1.6	$\frac{1}{2}$	$\frac{1}{2}$

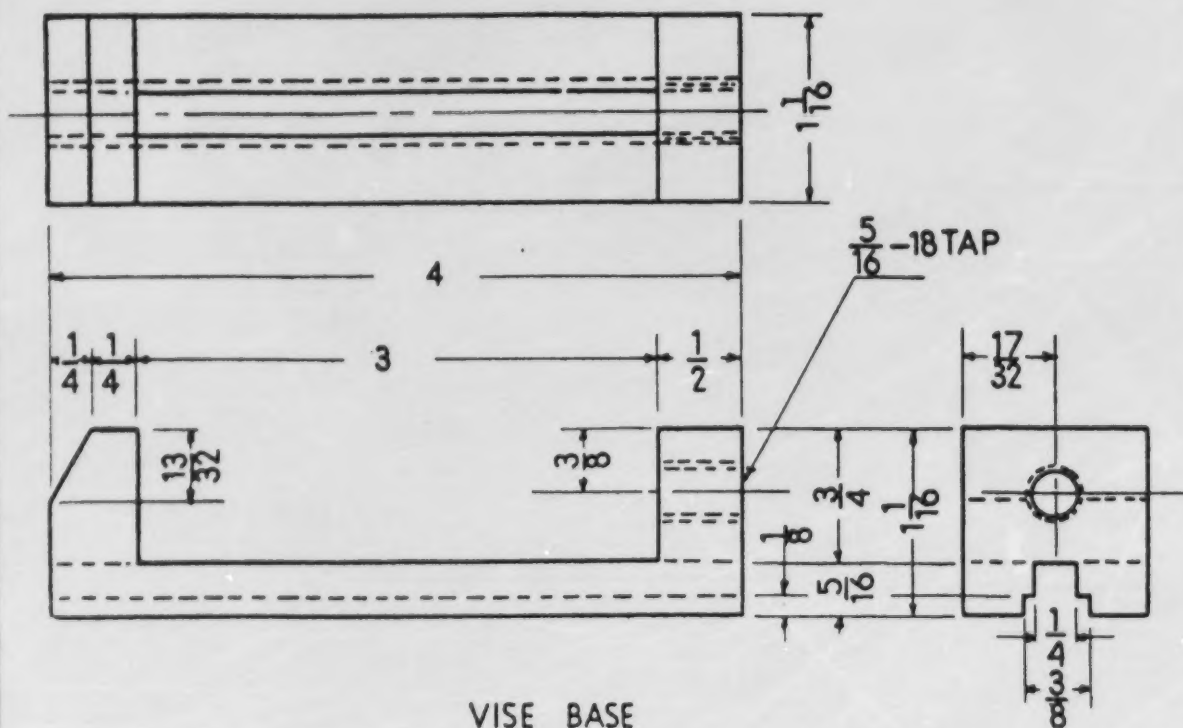


Machine Shop Job Sheet Series

Job No. 27

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Toolmakers Vise



WISE BASE

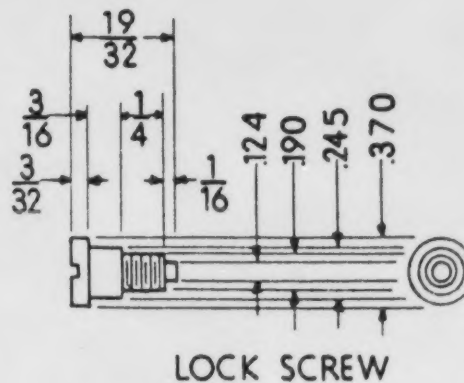
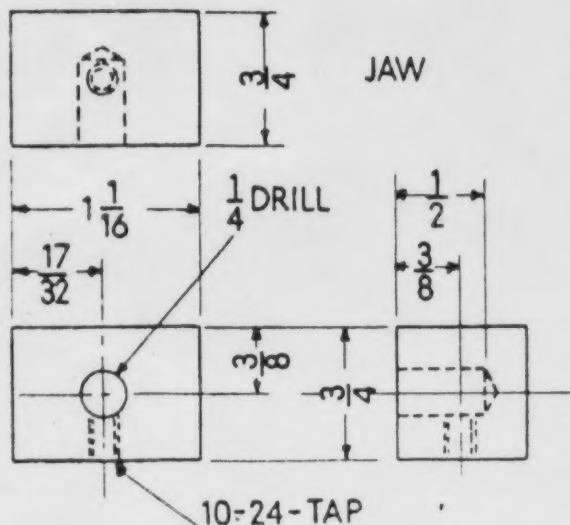
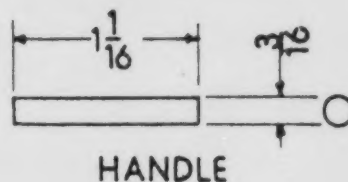
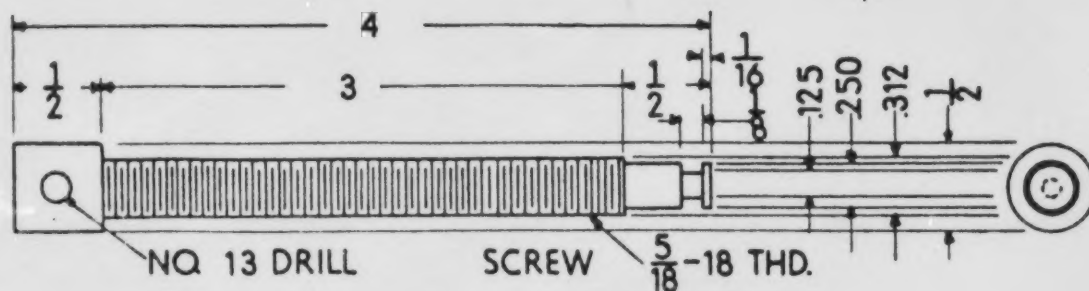
65

Machine Shop Job Sheet Series

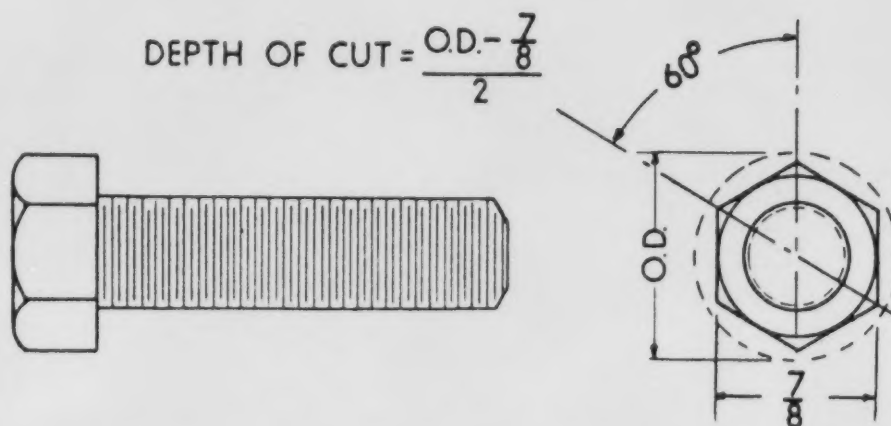
Job No. 28

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Toolmakers Vise Parts



Machine Bolt Head



INDEX FOR HEX = $\frac{40}{6}$ OR $6\frac{2}{3}$ TURNS

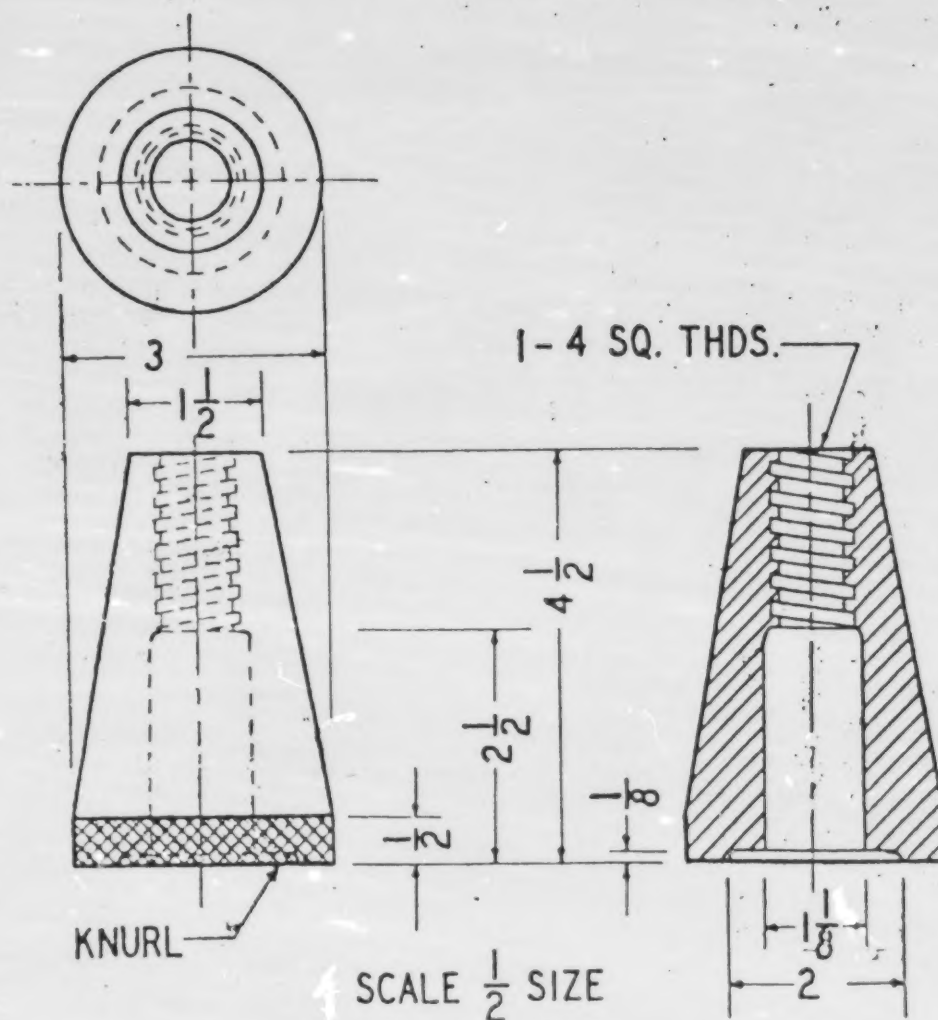
V-Block Clamp and Screw



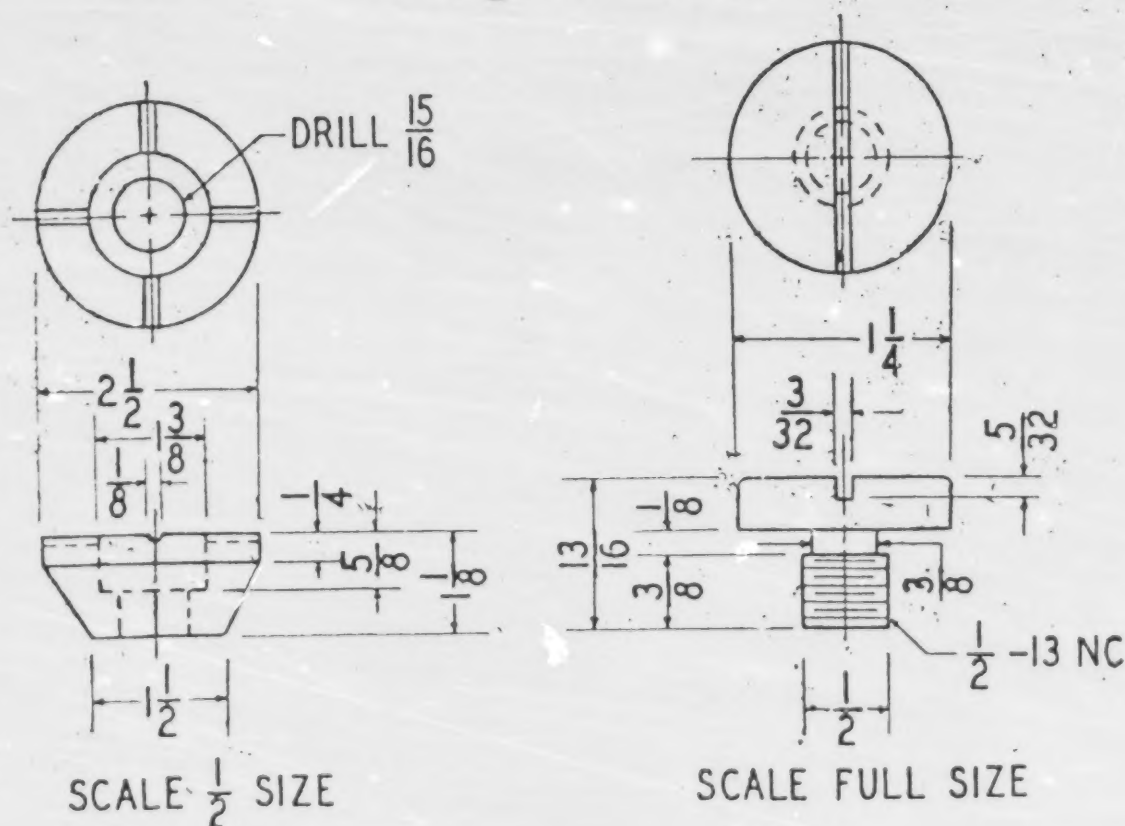
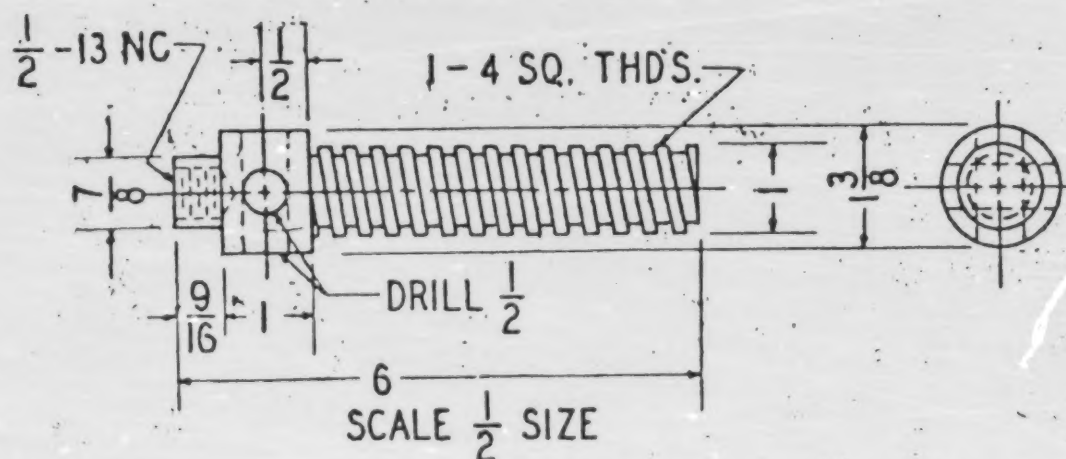
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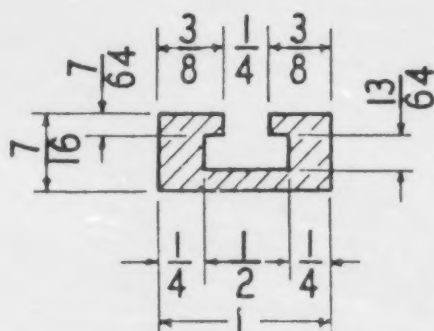
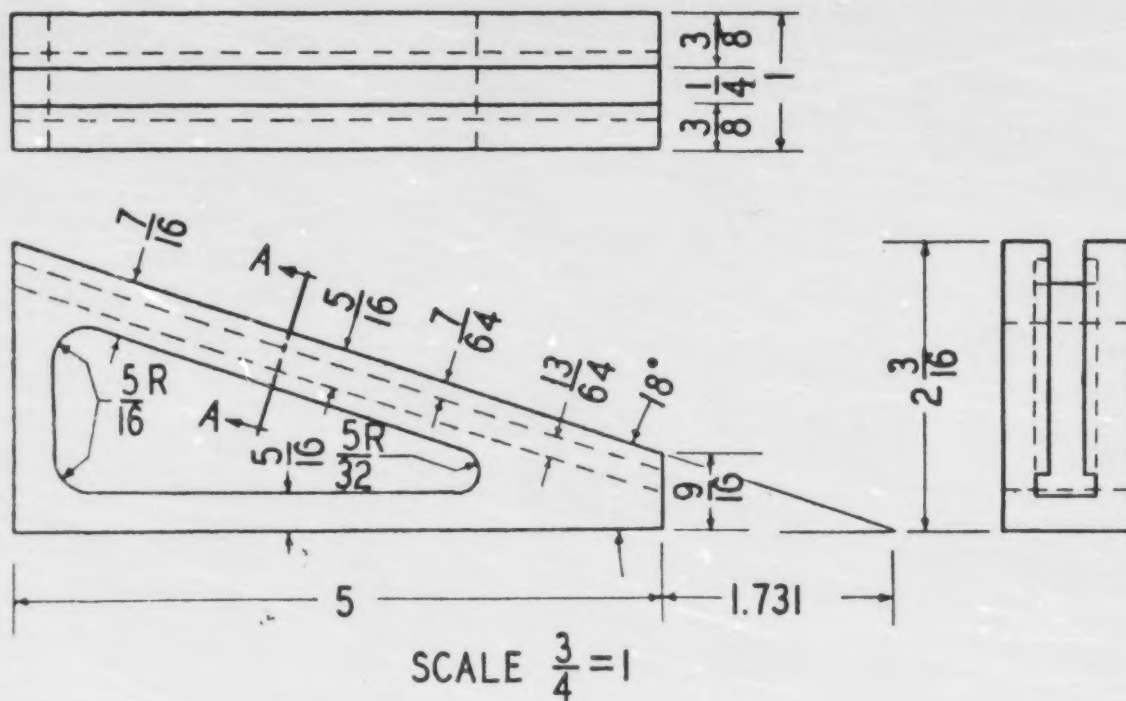
Screw Jack Base



Screw Jack Parts



Planer or Shaper Gauge Part



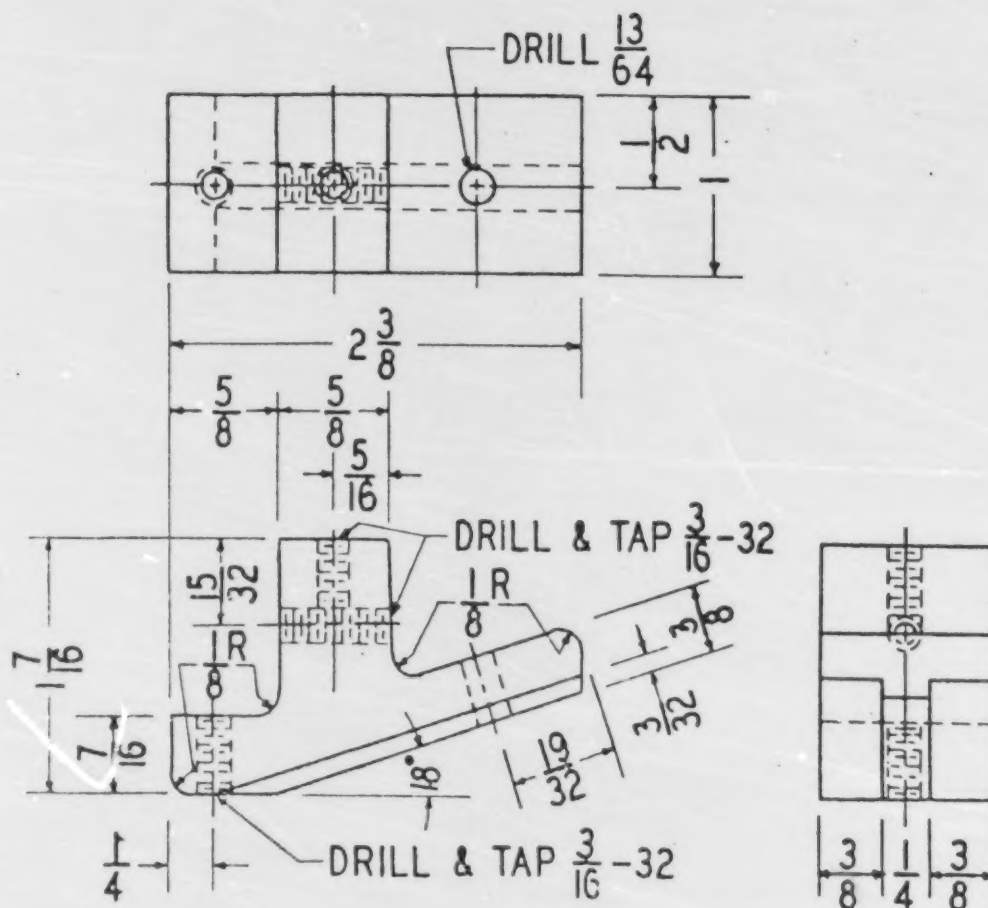
SECTION A-A
 SCALE - FULL SIZE

Machine Shop Job Sheet Series

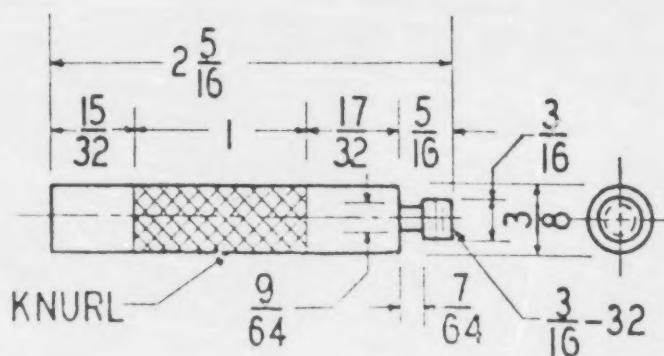
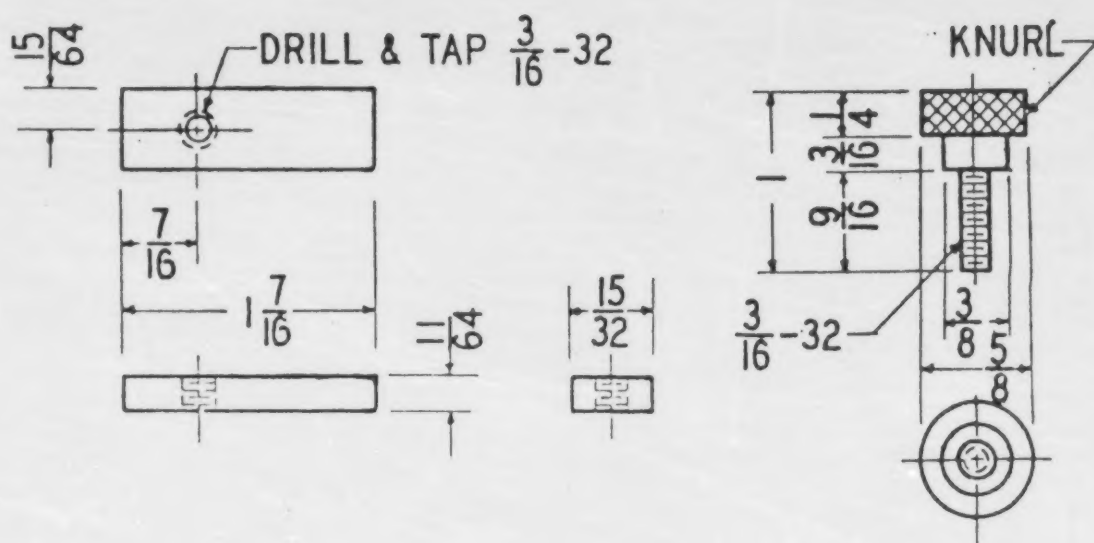
Job No. 34

WEST VIRGINIA
 State Board of Vocational Education, Division of Vocational Education
 Trade and Industrial Education Service
 Charleston 1

Planer or Surface Gauge Parts



Planer or Surface Gauge Parts

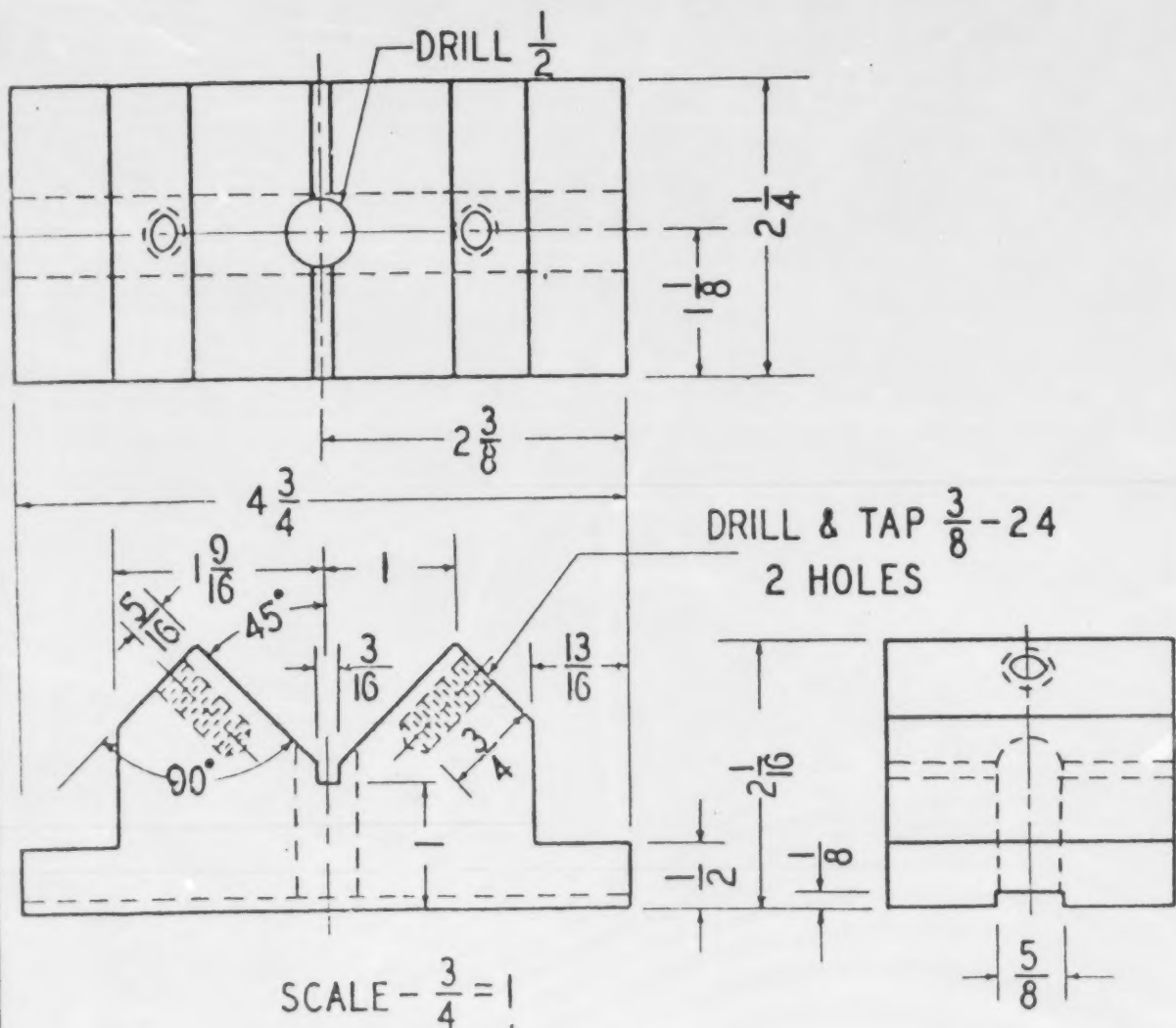


WEST VIRGINIA

State Board of Vocational Education, Division of Vocational Education
Trade and Industrial Education Service

Charleston 1

V-Block Part

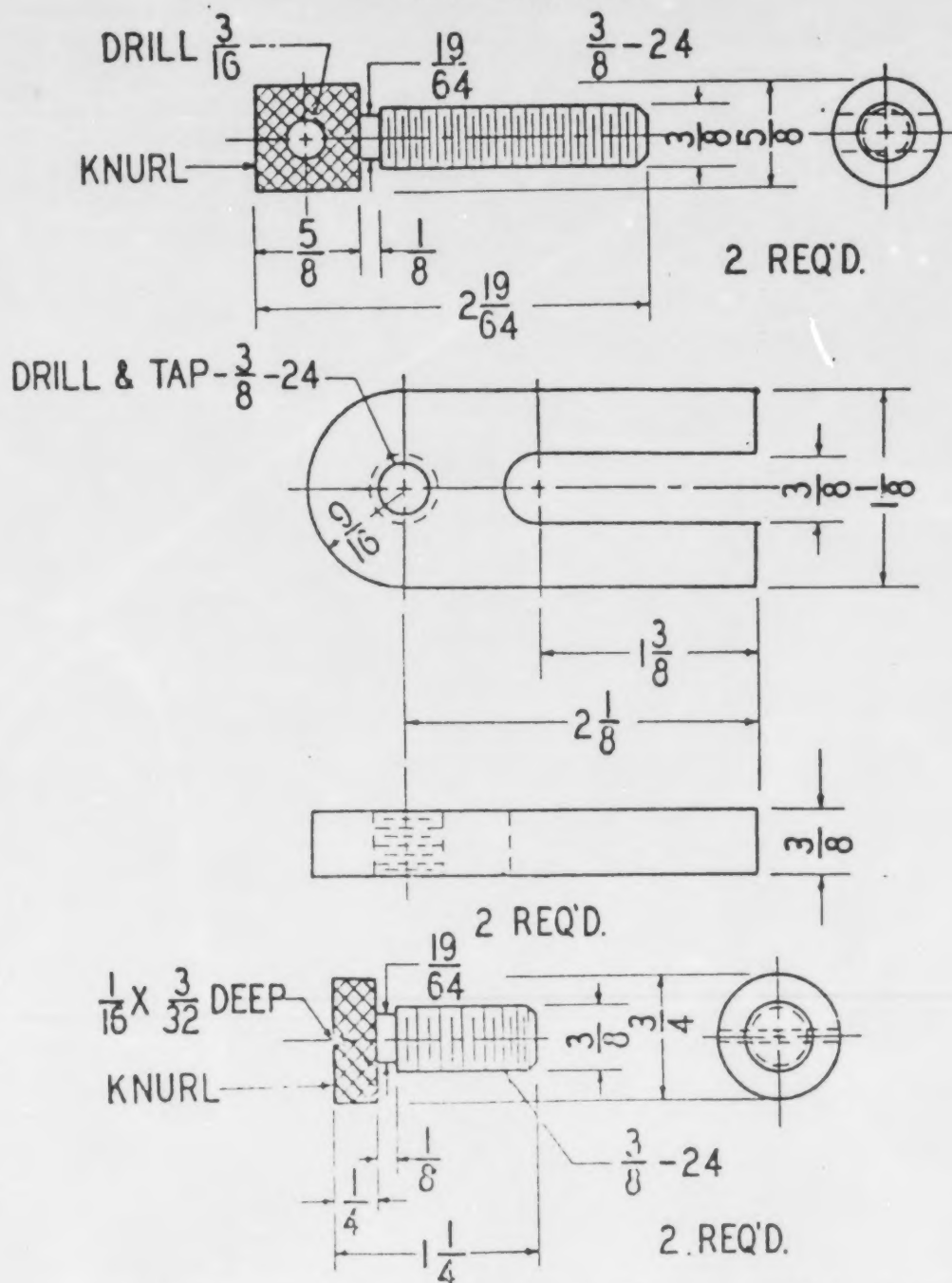


Machine Shop Job Sheet Series

Job No. 37

WEST VIRGINIA
State Board of Vocational Education, Division of Vocational Education
Trade and Industrial Education Service
Charleston 1

V-Block Parts

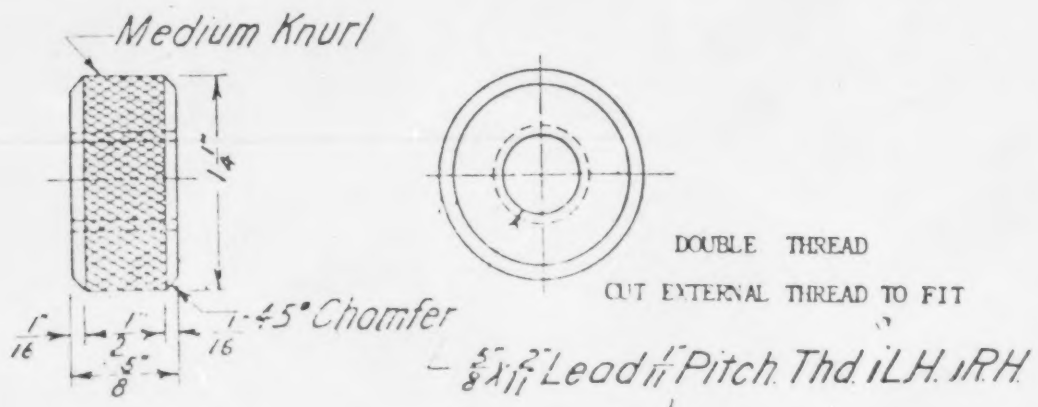
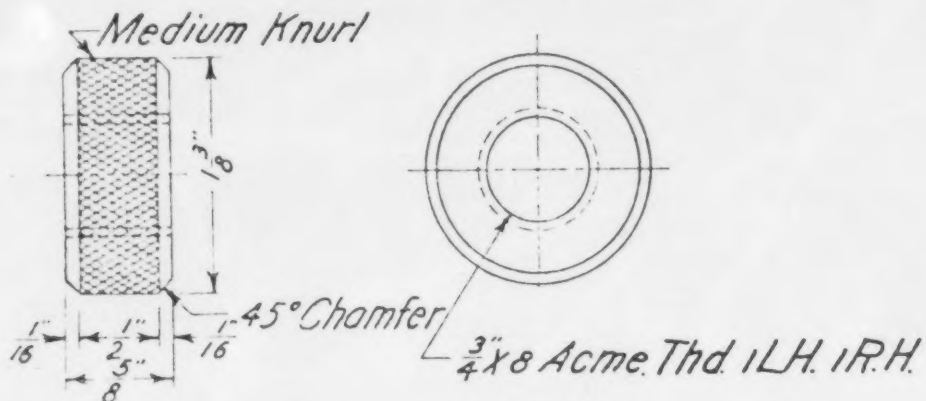
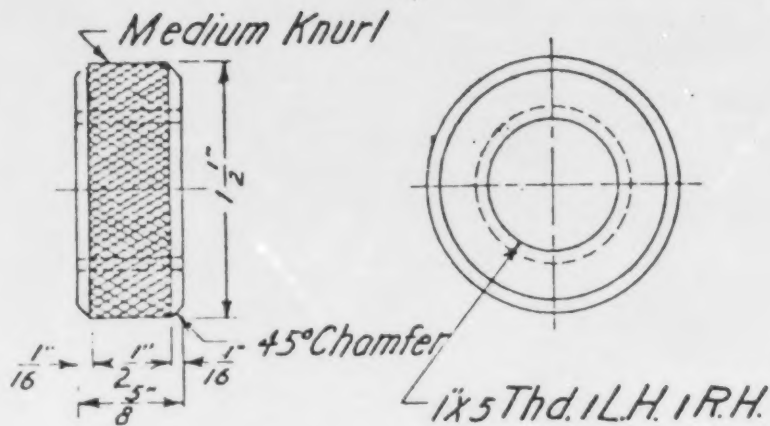


Machine Shop Job Sheet Series

Job No. 38

WEST VIRGINIA
State Board of Vocational Education, Division of Vocational Education
Trade and Industrial Education Service
Charleston 1

THREADING PRACTICE



Machine Shop Job Sheet Series

Job No. 39

STATE OF WEST VIRGINIA
DEPARTMENT OF EDUCATION

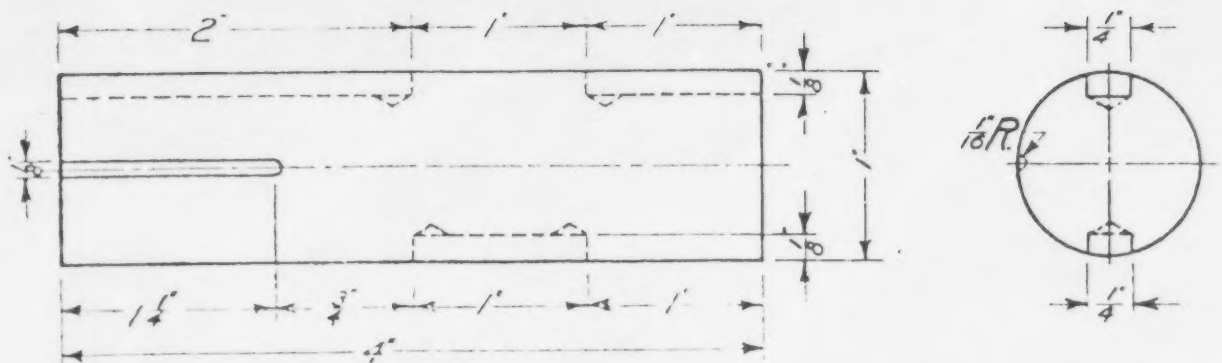
Trade and Industrial Service

Defense Training Vocational Program

Shaper Operation
Unit 5-5

Job Sheet Series
Sheet No. 1 of 1

KEYWAY PRACTICE



Note
Material, Hot Rolled Steel
77

STATE OF WEST VIRGINIA
DEPARTMENT OF EDUCATION

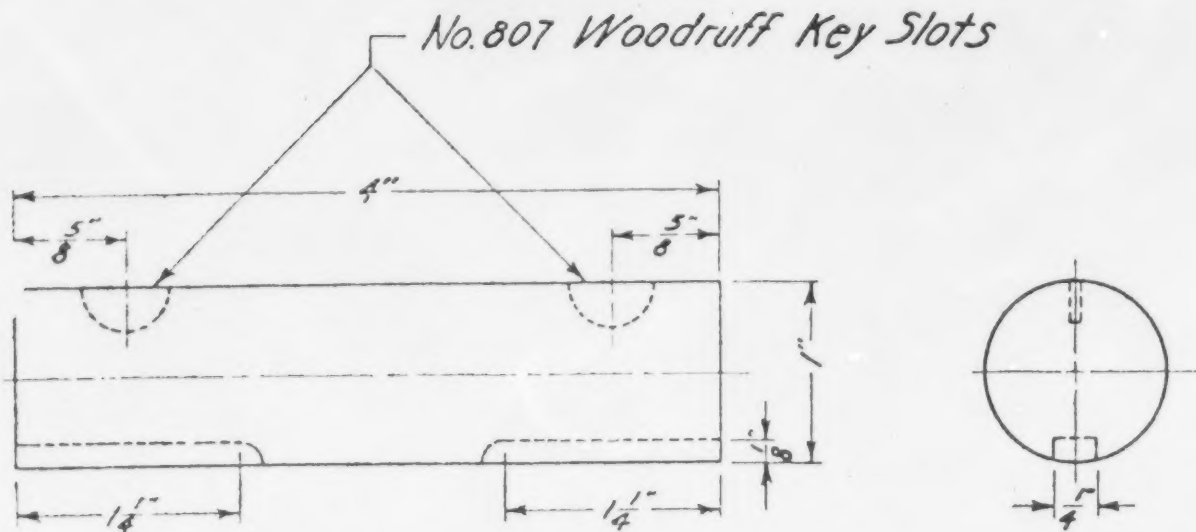
Trade and Industrial Service

Defense Training Vocational Program

Mill Operation
Unit 5-M

Job Sheet Series
Sheet No. 1 of 1

MILL KEY SLOT PRACTICE



Note
Material, Hot Rolled Steel

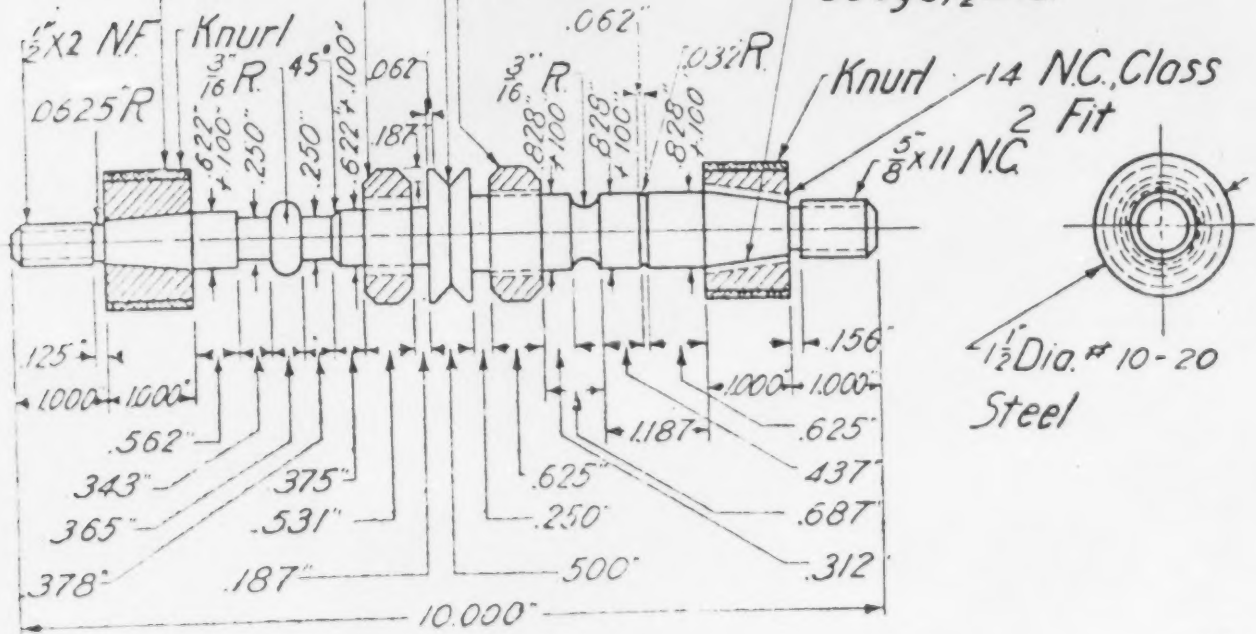
Defense Training Vocational Program

Job Sheet Series
Sheet No. 1 of 1

American Standard Screw Thread
Gauge, 1 1/2" Dia. Class 2 Fit 7/8 x 9 N.C. Major
Dia. max. 0.8750", min. 0.8550" Minor Dia.

V 45°-1.500" Dia. max. 0.7387" min. 0.7300"
American Standard Screw Thread
Gauge, 1/2" Dia. Class 2 Fit 1x8 N.C.L.H.
Major Dia., max. 1.000", min. 0.9848"
Minor Dia., max. 0.8466"
min. 0.828" No. 3 Morse
Standard Taper
Gauge 1/2" Dia.

No. 3 Morse
Standard Taper
Gouge, $1\frac{1}{2}$ " Dia.



Note 79

All shaft dimensions may vary $\pm .001$ " or $-.001$ "
Material, Hot Rolled Steel

TEACHER EVALUATION AIDS

AND

ANSWER KEYS

EVALUATION AIDS

PREFACE

Two types of tests are included in this section. You are cautioned against using any of the example tests without adequate review and selection.

Task Tests. Task tests are keyed according to Unit, Module, and Task numbers; for example, a test marked I-A-1 would key the test to Unit I, Module A, Task 1. You may use it as a teacher-graded test, or may believe it more useful as a learning tool. Thus, you have the option of administering the test and evaluating the answers, or distributing the questions and the answer key as a self-check test.

Unit Tests. Unit tests are keyed to each of the units. They are indicated, for example, as Unit Test, Unit A--Employment Opportunities. The unit tests may be utilized to measure learning as related to the entire unit, or they may be altered, supplemented, or reduced to measure the learning of selected tasks or modules.

The format of a major examination is critical in the appropriate and valid measurement of learning. Likewise, the structure and format of a unit test should present the written examination as a learning tool and not be seen as unusual or unlike learning activities in which the student has participated.

Teacher Evaluation

Unit A: EMPLOYMENT OPPORTUNITIES

I. True-False. Circle the correct answer:

1. T F The personal data sheet is often called a resume.
2. T F A personal data sheet includes more information than you'll need to provide on a job application form or in an interview.
3. T F Personal references are a waste of time. Employers never call them anyhow.
4. T F Having a Social Security card guarantees that you'll be given a job.
5. T F You don't have to tell prospective employers whether you're single, married, or divorced.
6. T F A letter of application is written only when applying for office jobs.
7. T F It's sometimes all right to look at your pre-written list of questions to be asked and items to be discussed during the interview.
8. T F Emphasizing your own good points during an interview makes you appear conceited.
9. T F If the interviewer has not said "no," it's all right to call back in a week or two to remind the company that you're still interested.
10. T F You should put something in all the blanks on a job application form except those marked for company use.

II. Multiple Choice. Circle the correct answer:

11. The D.O.T. number is:
 - a. The code which describes a job.
 - b. The projected number of employees needed in an occupational field.
 - c. The telephone number of the Bureau of Employment Security.
12. When writing out your work experience record:
 - a. Start with the most recent job and work backwards.
 - b. Start with the first job and work toward what you have done most recently.
 - c. The order of the jobs doesn't matter.

Unit A Test (Continued)

13. If an interviewer asks something you don't know or asks if you can do something you've never tried or cannot do, it's best to:
 - a. Not answer at all.
 - b. Fake it.
 - c. Be honest.
14. In most companies, the interviewer:
 - a. Hires the employees.
 - b. Screens the applicants.
 - c. Sets the wage or salary rate.
15. A supervisor is:
 - a. A person or company who hires people.
 - b. An individual who depends upon you for their support.
 - c. A person who works for another person or company.
16. Gross pay is:
 - a. The amount that is taken home.
 - b. The total amount paid before deductions.
 - c. The hourly rate of pay.
17. A job application:
 - a. Helps the interviewer judge your ability to follow directions.
 - b. Usually asks for unimportant information.
 - c. Tells nothing about you except the words that you have written.
18. Salary should be discussed:
 - a. First thing during the interview.
 - b. At the end of the interview.
 - c. Not at all.
19. Looking the interviewer in the eye is:
 - a. A way to show you're listening and interested.
 - b. Not necessary as long as you're listening.
 - c. Rude.

III. Define:

- | | |
|---------------------|-----------------|
| 20. Fringe benefits | 26. Salary |
| 21. Ethnic group | 27. Wage |
| 22. Nationality | 28. Limitations |
| 23. Marital status | 29. Deduction |
| 24. Dependent | 30. F.I.C.A. |
| 25. Management | |

Answer Key - Teacher Evaluation

Unit A: EMPLOYMENT OPPORTUNITIES

- I. 1. True
2. False
3. False
4. False
5. True
6. False
7. True
8. False
9. True
10. True

- II. 11. a
12. a
13. c
14. b
15. c
16. b
17. a
18. b
19. a

- III. 20. Things given an employee other than money.
21. Caucasian (white), Negroid (black), Indian, Asian, other.
22. Country where a person is born.
23. Single, married, divorced, or widowed.
24. An individual who depends upon you for support.
25. Those who make decisions.
26. Monthly or yearly contract payments.
27. The hourly rate of pay.
28. Health or physical condition that may hinder a person on the job.
29. That which is taken from a pay check.
30. F.I.C.A. (Federal Insurance Compensation Act) - money taken out for Social Security.

Teacher Evaluation

Unit B: HUMAN RELATIONS

I. True-False. Circle the correct answer:

1. T F The most important factor in job success is how well you perform the technical skills.
2. T F It's just as important to be a good follower as a good leader.
3. T F Morality is the value which has the greatest effect upon your personality.
4. T F Personal hygiene and good grooming are related to ethics.
5. T F Having to rely on another person for help or support of any kind makes a person unethical.

II. Multiple Choice. Circle the correct answer (a, b, c, or d):

6. A natural talent which makes it easy to learn certain things is:
 - a. Ability
 - b. Interest
 - c. Aptitude
 - d. Foresight
7. Having good manners and a true concern for the comfort of others is:
 - a. Self-control
 - b. Courtesy
 - c. Tact
 - d. Sense of humor
8. Being able to see both sides of a question or argument:
 - a. Morality
 - b. Open-mindedness
 - c. Duplicity
 - d. Initiative
9. The ability to get along with others:
 - a. Something you are born with
 - b. Honesty
 - c. Punctuality
 - d. Learned

Unit B Test (Continued)

III. Completion.

Write the word that completes the statement in the blank to the left of the statement.

10. _____ A _____ acts as a bridge between the people who run the company and the employees.
11. _____ Your _____ is determined by how well your needs are satisfied, how others react to you, and how closely you measure up to the ideal you have set for yourself.
12. _____ A _____ is an established pattern of behaving in relation to other people.
13. _____ _____ is the exchange of information, feelings, and ideas which is the basis for the development of relationships among people.
14. _____ If you can handle situations so that no one becomes offended and if you say the right thing at the right time, you possess _____.

Answer Key - Teacher Evaluation

Unit B: HUMAN RELATIONS

- I. 1. False
- 2. True
- 3. False
- 4. True
- 5. False

- II. 6. c
- 7. b
- 8. b
- 9. d

- III. 10. Supervisor
- 11. Self-concept
- 12. Role
- 13. Communications
- 14. Tact

Teacher Evaluation

Unit B: HUMAN RELATIONS Task 1: Understand Yourself

Read the following list of words. Find the word which best fills in the blank in the corresponding statements. Place the letter in the blank provided at the left of the statement.

- | | |
|---------------------------------|--------------------|
| A. personal appearance | I. dependable |
| B. able | J. sense of humor |
| C. foresight | K. self-control |
| D. health habits | L. open mindedness |
| E. punctuality | M. morality |
| F. tact | N. honesty |
| G. courtesy | O. initiative |
| H. attitude toward other people | P. aptitude |

- _____ 1. When we say that people have ability to do something, we mean they are _____ to do it.
- _____ 2. When people seem to be born with natural talent which makes it easy to learn certain things, we say that they have _____ for these things.
- _____ 3. The value which has the greatest effect upon your personality shows in your _____.
- _____ 4. _____ means having two (2) things: good manners and a true concern for the comfort of others.
- _____ 5. People who always complete the work given them on the job are _____.
- _____ 6. To look and plan ahead displays _____.
- _____ 7. Good _____ help you feel, act, and look your best.
- _____ 8. If you can see that things need to be done and do them, you have _____.
- _____ 9. Being able to see both sides of a question or argument means _____.
- _____ 10. Being on time describes _____.
- _____ 11. If you can see the funny side of life, you have a _____.
- _____ 12. If you can say the right thing at the right time, and handle situations so that no one becomes offended you possess _____.

Answer Key - Teacher Evaluation

Unit B: HUMAN RELATIONS Task 1: Understand Yourself

1. B - able
2. P - aptitude
3. H - attitude toward other people
4. G - courtesy
5. I - dependable
6. C - foresight
7. D - health habits
8. O - initiative
9. L - open-mindedness
10. E - punctuality
11. J - sense of humor
12. F - tact

Teacher Evaluation

Unit B: HUMAN RELATIONS Task 2: Understand Successful Work Attitudes

Answer each by circling "T" for true, or "F" for false. You must answer twelve (12) out of fifteen correctly. No references may be used.

- | | | | |
|---|---|-----|--|
| T | F | 1. | The most important factor in job success is attitude. |
| T | F | 2. | About two-thirds of the young workers who lose their jobs do so because of poor attitude. |
| T | F | 3. | Those who are most agreeable to take on unpleasant tasks are often the first to be awarded with pay increases. |
| T | F | 4. | It is not important to be friendly with your co-workers. |
| T | F | 5. | If you cannot be loyal to your employer and your company, you should look for another job. |
| T | F | 6. | Regardless of how a criticism was meant, it is constructive or destructive depending on how you use it. |
| T | F | 7. | If you are too ill to go to work, it is best to stay home, and then let the employer know why you missed work as soon as you are well. |
| T | F | 8. | It is not fair for an employer to criticize your work until you have had time to learn the job. |
| T | F | 9. | Most employers like workers who follow directions exactly as given. |
| T | F | 10. | The behavior we develop by the time we leave school affects us for the rest of our lives. |
| T | F | 11. | The ability to get along with others is something that you are "born with" - it can't be learned. |
| T | F | 12. | Written evaluations of your work by your employer are legal. |
| T | F | 13. | A sense of humor is the ability to laugh when the joke is on you. |
| T | F | 14. | Criticism is necessary in the job situation. |
| T | F | 15. | It is best to become close friends with a co-worker during the first week or two on the job. |

Answer Key - Teacher Evaluation

Unit B: HUMAN RELATIONS Task 2: Understand Successful Work Attitudes

1. T
2. T
3. T
4. F
5. T
6. T
7. F
8. F
9. T
10. T
11. F
12. T
13. T
14. T
15. F

Activity Test

Unit B: HUMAN RELATIONS Task 2: Understand Successful Work Attitudes

"5-Minute Timed Test on Following Directions"

How well do you follow directions? You should be able to complete all the things required in five (5) minutes by following the directions below. Your teacher may wish to time you to see who can finish first, second, etc., so turn your paper over to show when you have completed all the work.

Do not begin until your teacher says "go," then follow directions exactly as given. You will need one (1) sheet of notebook paper.

1. Read all directions before doing anything.
2. On a sheet of notebook paper, write your name in the upper right corner.
3. Number from one (1) to seven (7), leaving three (3) blank lines between each number.
4. Draw five (5) small squares beside the number one (1) on your paper.
5. Put an "X" in each square beside number one (1).
6. Put a circle around the number two (2) on your paper.
7. Count the number of pages in Chapter Four (4) of your book and write the answer beside number three (3) on your paper.
8. Multiply the answer above by your age.
9. Say your name out loud.
10. Beside number four (4), write today's date.
11. Beside number five (5), write the city and state where you were born.
12. Count the number of persons in the room and write the answer beside number six (6).
13. Say, "I have reached number 13, and I am following directions carefully."
14. Now that you have completed the reading, omit all directions except the first two (2).

Teacher Evaluation

Unit B: HUMAN RELATIONS Task 3: Use Principles of Human Relations

The following true/false questions deal with the Principles of Human Relations. Place a circle around the letter which represents the correct answer.

- T F 1. The ability to make things happen is important both in your social life and in your career.
- T F 2. Some things we do for no reason at all.
- T F 3. We are more effective in our human relationships if we know why others behave as they do.
- T F 4. Everything we do is because we want something.
- T F 5. Leaders are "born" not "made."
- T F 6. Human beings usually behave on the basis of what is logical.
- T F 7. Everyone has some feelings of insecurity.
- T F 8. Showing a sincere interest in someone can help you influence that person.
- T F 9. Although a smile may be useful in your social life, it is of little value in your career.
- T F 10. Putting up a good argument will help you influence others.
- T F 11. Catching other people in the right mood is an important factor in making them behave as you would like.
- T F 12. Once you can show that another person has made a mistake, it is important that you get him or her to admit it.
- T F 13. Everyone has a basic need to feel important.
- T F 14. It is easier to influence another with praise than with criticism.
- T F 15. You can tell a great deal about a person by observing his or her mannerisms.

Answer Key - Teacher Evaluation

Unit B: HUMAN RELATIONS Task 3: Use Principles of Human Relations

1. T
2. F
3. T
4. T
5. F
6. F
7. T
8. T
9. F
10. F
11. T
12. F
13. T
14. T
15. T

Teacher Evaluation

Unit I: MAINTAINING SHOP FACILITIES AND WORK AREAS

1. Name five (5) commonly found metals in machine shop.
2. Write five (5) safety practices when cleaning shop area.
3. Write a procedure for painting equipment.
4. Write five (5) visual equipment safety checks.

Answer Key - Teacher Evaluation

Unit I: MAINTAINING SHOP FACILITIES AND WORK AREAS

1.
 - a. Tool steel
 - b. Mild steel
 - c. Aluminum
 - d. Brass
 - e. Copper
2.
 - a. Never use your hands to clean or brush chips
 - b. Wear safety equipment
 - c. Do not use air pressure to blow metal chip
 - d. Dispose of waste and oily rags in proper location
 - e. Do not attempt to clean equipment while it is operating
3.
 - a. Protect machined surfaces and surrounding area
 - b. Disconnect power
 - c. Scrape, wire brush, or sand area to be painted
 - d. Prime area
 - e. Scuff with fine paper and wipe clean
 - f. Apply first coat of top coat
 - g. Apply second top coat if needed
 - h. Clean up tools, work area, and dispose of rags in proper manner
4.
 - a. Belt guards in place and functional
 - b. Belts properly adjusted
 - c. Electrical controls functional
 - d. Tool and cutter properly mounted
 - e. Work holding devices in proper repair

Teacher Evaluation

Unit II: PERFORMING MATHEMATICAL CALCULATIONS

1. Name the parts of a micrometer.
2. Name four (4) types of micrometers.
3. What is the largest size you can measure with a 1" micrometer?
4. What is the smallest size you can measure with a 2" micrometer?
5. Write the decimal equivalents of:

a. $1/2$	d. $1/16$
b. $1/4$	e. $1/32$
c. $1/8$	f. $1/64$
6. Write the decimal equivalents of:

a. $47/64$	d. $15/16$
b. $13/32$	e. $7/8$
c. $19/64$	f. $57/64$
7. Write the metric conversion for:

a. $1/4"$	e. 0.455"
b. $1/2"$	f. 0.970"
c. 3"	g. 3.175"
d. $5\ 5/8"$	h. 4.666"
8. A work piece is $3/4"$ in diameter and the blueprint calls for 0.675 diameter. How much material must be removed?
9. A blueprint calls for a piece of material to be turned on an engine lathe and to be $5.250 \pm .001$ in length. Your selection of stock is:

a. 5.250"	b. 5.500	c. 6.000
-----------	----------	----------

Select the best piece.
10. Define Rockwell Hardness Test.
11. List three (3) types of hardness testers.
12. What is the surface speed, in feet per minute, of a 10" grinding wheel at 1800 RPM?
13. How many RPM should a $7/8"$ diameter carbon steel drill make to cut medium carbon steel?

Answer Key - Teacher Evaluation

Unit II: PERFORMING MATHEMATICAL CALCULATIONS

1. Frame, anvil, spindle, lock nut, sleeve, thimble, barrel, adjusting nut, ratchet body, ratchet screw
2. a. Outside micrometer
b. Inside micrometer
c. Depth micrometer
d. Screw thread micrometer
3. 1.0"
4. 1.0"
5. a. .500 c. .125 e. .03125
b. .250 d. .0625 f. .01562
6. a. .734 c. .297 e. .875
b. .406 d. .9375 f. .891
7. a. .635 cm or 6.35 mm e. 1.1557 cm
b. 1.27 cm or 12.7 mm f. 2.4638 cm
c. 7.62 cm g. 8.0645 cm
d. 14.287 cm h. 11.8516 cm
8. .075 inch
9. b. 5.250
10. Depth of penetration made in metal by a specific kind of penetrator point under a specific load
11. a. Rockwell
b. Brinell
c. Shore Scleroscope
12. 56, 520 feet/minute
13. 133 - 150 RPM

Teacher Evaluation

Unit III: PERFORMING BENCH WORK

1. Name the major parts of a hand hacksaw.
2. Which way should the teeth of a hacksaw point when correctly installed?
3. What is the difference between a tap and a die?

The major test for this duty would be the actual performance of the tasks within the unit.

Answer Key - Teacher Evaluation

Unit III: PERFORMING BENCH WORK

1. Frame, handle, blade
2. Away from the handle
3. Taps are used to cut internal threads
Dies are used to cut external threads

Teacher Evaluation

Unit IV: OPERATING PRESSES

1. Name the major parts of an arbor press.
2. Define the term "jig".
3. List type of operations that can be performed on presses.

The major test for this duty would be performance of the tasks within the unit.

Answer Key - Teacher Evaluation

Unit IV: OPERATING PRESSES

1. Anvil, ram
2. A means of holding a work piece
3.
 - a. Remove and replace pressed parts
 - b. Straighten miscellaneous parts
 - c. Broaching
 - d. Punching

Teacher Evaluation

Unit V: OPERATING DRILL PRESSES

1. Name the major parts of a drill press.
2. List five (5) operations that are performed on a drill press.
3. What size drills would commonly be used to drill a half inch diameter hole in steel?
4. What does RPM stand for?
5. Should a small drill run slower or faster than a large drill when drilling the same material?
6. How can you tell when a drill is running too fast?
7. Should a tapered shank drill be placed in a drill chuck? Why?
8. What kind of drill should be placed in a drill chuck?
9. What is the difference between counterboring and countersinking?
10. What size drill should be used for a 7/8" reamed hole?
11. What size drill should be used for a 2" reamed hole?
12. What size drill should be used for a 3/4 UNC tap?
13. Define UNC and UNF.
14. What is the purpose of center punching before drilling?

Answer Key - Teacher Evaluation

Unit V: OPERATING DRILL PRESSES

1. Base, table, column, spindle sleeve, head
2. a. Drilling c. Reaming e. Countersinking
b. Boring d. Counterboring f. Tapping
3. a. 1/8", 1/4", 3/8" and 1/2"
4. Revolutions per minute
5. Faster
6. The corners of the cutting edge wear away quickly
7. No - You will not be able to secure the drill in the chuck
8. Straight shank drills
9. Countersinking is cutting at an 82° for screws
Counterboring is cutting a flat surface for bolts
10. 55/64"
11. 1 31/32"
12. 21/32"
13. Unified National Coarse (UNC)
Unified National Fine (UNF)
14. Centers the work piece to the drill and prevents drifting of the drill

Teacher Evaluation

Unit VI: OPERATING POWER SAWS

1. Name three (3) types of power cut off machines.
2. Can hardened steel be cut in a power saw? Why?
3. What is meant by the feed of a saw?
4. Which way should the teeth of a power hacksaw point?
5. Which way should the teeth of a horizontal bandsaw point?
6. What is the advantage of using cutting fluid?
7. List the type of tooth set on power hacksaw blades.
8. List three (3) types of horizontal bandsaw blades.
9. What kinds of cuts may be made on horizontal bandsaws?
10. What kinds of cuts may be made on vertical bandsaws?
11. What is the necessary precaution to be observed when changing the speed on a machine equipped with variable speed drive mechanisms?
12. Recommended cutting speeds for bandsawing vary according to four (4) important factors. List them.
13. What recommendation should be followed concerning bandsaw blade tension?
14. Explain the purposes of ship tooth bandsaw blades.

Answer Key - Teacher Evaluation

Unit VI: OPERATING POWER SAWS

1.
 - a. Power hacksaw
 - b. Horizontal bandsaw
 - c. Vertical bandsaw
2. No - the teeth of the blade must be harder than the material being cut
3. The amount of pressure applied to the blade
4. Teeth face forward, away from the operator
5. Face forward or in the direction of rotation
6. Saves the blade and reduces time needed to cut material
7. Raker set
8. High-carbon steel, special alloy steel and high speed steel
9. Cut off work square or at an angle
10. Straight line cuts, angular cuts, curved lines (contouring)
11. Change the speed only while the machine is running
12.
 - a. Kind of material being cut
 - b. Hardness of the material
 - c. Thickness of material
 - d. Whether the cutting is wet or dry
13. Following the manufacturer's instructions for blade tension
14. They are used for cutting non-ferrous metals and can operate at a higher speed

Teacher Evaluation

Unit VII: OPERATING LATHES

1. What kind of operations can be performed on a lathe?
2. Name the main parts of a lathe.
3. How is the size of a lathe measured?
4. Why should one avoid turning the lathe on when the spindle is locked?
5. List the formula for calculating the approximate cutting speed for lathe work.
6. List the formula for calculating the approximate RPM for lathe work.
7. For what purposes are back gears used on a lathe?
8. What is meant by longitudinal feed on a lathe?
9. What is meant by cross feed?
10. At what angle is the compound rest set for normal operations?
11. What control is used to engage the feed for thread cutting?
12. List three (3) types of lathe chucks.
13. What kind of pieces can be held in a four jaw chuck?
14. Why should lathe chucks be screwed on or off the headstock spindle while the lathe is stopped?
15. What is meant by end relief?
16. What is meant by side relief?
17. What is meant by facing?
18. For what purpose are the set over screws on the tail stock used?
19. Why should lathe centers be free from dirt before installing them in the lathe?
20. Why are holes bored rather than just drilling them to the desired size?
21. For what purpose is a steady rest used on a lathe?
22. What kind of cutting tool is used for cutting internal threads on a lathe?

Answer Key - Teacher Evaluation

Unit VII: OPERATING LATHES

1. Turning - straight, curved or irregular cylindrical, knurling, thread cutting, drilling, boring, reaming
2. Head stock, tail stock, compound rest, carriage, bed, ways, saddle, gear box, back gears, lead screw, rack, feed reverse lever, apron, feed change
3. Swing and length of bed
4. Damage can be done to the belt drive
5. $CS = \frac{D'' \times \pi \times RPM}{12}$
6. $RPM = \frac{CS' \times 12}{D'' \times \pi}$
7. Back gears produce slow speeds
8. The apron moves from head stock to tail stock or visa versa
9. The compound rest is moved at right angles to the head stock
10. 29°
11. Half nut lever
12. Four (4) jaw independent chuck, three (3) jaw universal chuck and collet chucks
13. Hold work that is not perfectly round, square, rectangular or irregular in shape
14. They are heavy and could fall on the way or your hands
15. The angle formed at the nose, between the ground end of the tool and the work
16. Angle between the flank and a vertical plane or the work being cut
17. Cutting or squaring the end of the work piece
18. To align the tail stock and the head stock and to cutting tapers
19. The centers will not be aligned and the work will be cut on a taper
20. The boring technique is more accurate
21. Hold long bar rigid or steady while being turned
22. Boring bar

Teacher Evaluation

Unit VIII: OPERATING SHAPERS

1. List five (5) kinds of surfaces that can be machined with a shaper.
2. List two (2) ways a work piece can be mounted on the shaper.
3. What is the principal advantage in machining flat surfaces with a shaper?
4. What is the principal disadvantage in machining flat surfaces with a shaper?
5. How is the size of a shaper generally designated?
6. List six (6) principal parts of a shaper.
7. List eight (8) principal parts of the tool head assembly.
8. How much longer should the stroke of the ram be than the length of the work piece?
9. What depth of cut is generally recommended for making finishing cuts with a finishing tool?
10. Does the table feed crosswise during the cutting stroke or return stroke?
11. Why should one run the ram through its complete stroke with the hand wheel before operating the machine with power?
12. List five (5) safety practices for shapers.
13. List three (3) kinds of tool holders which can be used on the shaper.
14. Which is used more frequently on the shaper, right or left hand tools?

Unit VIII: TEST (Continued)

The student will also be able to perform the following operation
on the shaper:

1. Machine horizontal surfaces to specifications
2. Machine vertical surfaces to specifications
3. Machine angular surfaces to specifications
4. Machine external keyways
5. Machine internal keyways
6. Calculate speeds and feed rates

Answer Key - Teacher Evaluation

Unit VIII: OPERATING SHAPERS

1. a. Horizontal flat surfaces d. Slots
b. Vertical flat surfaces e. Curved surfaces
c. Grooves
2. a. Vise
b. Bolted directly to table
3. The cutter can be easily ground to another shape and easily sharpened
4. The rate of metal removal is slow
5. Size is designated by the maximum length of stroke
6. a. Table d. Table support
b. Ram e. Vise
c. Head assembly f. Feed control
7. a. Down feed handle e. Hinged clapper block
b. Tool slide f. Apron
c. Graduated head swivel base g. Tool post
d. Clapper box h. Cutting tool
8. 3/4 of an inch
9. 0.005" to 0.015"
10. Return stroke
11. To check alignment of work piece and cutter
12. a. Always wear safety goggles
b. Make sure work piece and cutter are secure
c. Use the right cutting tool
d. Remove all wrenches or other tools before operating shaper
e. Select the proper feeds and speeds
13. a. Shaper tool holder
b. Lathe tool holder
c. Extension tool holder
14. Left hand cutting tools

Teacher Evaluation

Unit IX: OPERATING GRINDING MACHINES

1. List three (3) types of grinding machines.
2. What is meant by surface grinding?
3. What is meant by cylindrical grinding?
4. What is meant by centerless grinding?
5. Why should the spindle rpm of a grinding machine never exceed the maximum recommended rpm for the grinding wheel?
6. What kind of cutting fluid is recommended for wet grinding of ferrous metals?
7. What is meant by truing?
8. What is meant by dressing?
9. What is meant by nonprecision grinding?
10. What is meant by precision grinding?

Answer Key - Teacher Evaluation

Unit IX: OPERATING GRINDING MACHINES

1. Surface grinder, cylindrical grinder, centerless grinder
2. Produce a true flat surface
3. External grinding of round parts
4. Form of cylindrical grinding - the work piece is not held between centers
5. The grinding wheel can explode or break apart
6. Emulsifiable (soluble) oil solution
7. Truing - cut the wheel so that there are no high spots
8. Dressing - sharpening the wheels
9. Grinding that does not require working to tolerances
10. Grinding to tolerances

Teacher Evaluation

Unit X: OPERATING MILLING MACHINES

1. List the three (3) directions in which the table can be adjusted on a knee-and-column type milling machine.
2. List three (3) different classifications or types of knee-and-column type milling machines.
3. List two (2) types of horizontal milling machines.
4. List five (5) kinds of operations which can be performed on a universal milling machine.
5. List one (1) operation that can be performed on a vertical milling machine that cannot be performed on a horizontal milling machine.
6. What is the purpose of the rapid-traverse control on the milling machine?
7. Explain the difference between up-milling and down-milling.
8. What purpose do spacing collars serve on milling arbors?
9. List six (6) types of milling cutters.
10. List three (3) types of material used for milling cutters.
11. List six (6) factors effecting cutting speeds for milling operations.
12. Write the formula for calculating RPM on the milling machine.
13. Write the formula for calculating rate of feed for the milling machine.

As part of the test the student will be required to set up the milling machine for all the tasks listed in this unit without using the Performance Checklist.

Answer Key - Teacher Evaluation

Unit X: OPERATING MILLING MACHINES

1. a. Vertically
b. Longitudinally
c. Transverse
2. a. Horizontal
b. Vertical
c. Combination vertical-horizontal
3. a. Plain
b. Universal
4. a. Flat horizontal
b. Vertical surface
c. Angular surfaces
d. Curved surfaces
e. Irregular surfaces
5. Drilling or boring
6. To move the work piece rapidly between milling operations
7. Up-milling The chip increases in size during the cut
Down-Milling The chip size decreases during the cut
8. They are used to set separate cutters
9. a. Plain milling cutters
b. Side milling
c. Metal slitting saws
d. Angular milling cutters
e. End mill cutter
f. Shell end mills
10. a. Carbon tool steel
b. High speed steel
c. Tungsten carbide
11. a. Kind of metal being machined
b. Machinability rating of the metal
c. Hardness of the metal
d. Kind of cutting tool material
e. Proper cutting fluid
f. Depth of cut and rate of feed
12. $RPM = \frac{CS \times 12}{D} \times \pi$
13. $F = R \times T \times RPM$

Teacher Evaluation

Unit XI: PERFORMING METALWORK OPERATIONS

The student would be given a job assignment, access to the tools, machinery and materials; the finished work piece would be completed to the specifications of the job assignment blueprint.

Teacher Evaluation

Unit XII: DESIGNING AND PLANNING METAL WORK

1. Given a rough sketch and the function of the part, the student will design a functional work piece.

Teacher Evaluation

Unit XIII: PERFORMING SUPERVISORY FUNCTIONS

1. The student will supervise the operation of the shop for given period of time.
2. The student will do an inventory of the supplies.

Teacher Evaluation

Unit XIV: MAINTAINING MACHINES AND TOOLS

1. The student will clean and repair assorted hand tools, cutters, fixtures and attachments.
2. The student will perform general maintenance operations, such as oiling and cleaning equipment and replacement of belts.

REFERENCE MATERIALS

REFERENCE MATERIALS FOR MACHINE SHOP CURRICULUM

Part I of this section lists reference materials specified in the learning activities of this curriculum. It is recognized that many of the recommended books or audio-visual materials may not be currently available in local school programs or libraries. Many may, however, be available on loan from:

Vocational Curriculum Laboratory
Cedar Lakes Conference Center
Ripley, West Virginia 25271
(304-372-8673)

Part II is a list of other resources that may be useful. These, too, may be available from the Cedar Lakes Vocational Curriculum Laboratory.

Part I - References Cited in Learning Activities

A. Texts/Reference Books

1. Archer, Fred C., Raymond F. Brecker, John C. Frakes, John C. Stewart, and Jeffrey Rig. General Office Practice, 3rd ed. New York, NY: McGraw-Hill, 1968.
2. Black, Perry O. Machinists Library; Basic Machine Shop. Indianapolis, IN: Theodore Audel and Company, a Division of Howard W. Sams and Company, Inc, 1970.
3. Black, Perry O. Machinists Library; Toolmakers Handy Book, 2nd ed. Indianapolis, IN: Theodore Audel and Company, a Division of Howard W. Sams and Company, Inc., 1970.
4. Bohlmann, Hubert. Machine Shop: Competency-Based Education Curriculum. Wheeling, WV: McKinley Vocational-Technical Center, 1975.
5. Bolles, Richard. What Color Is Your Parachute? Penn Speed Press.
6. DeBrum, S. Joseph, Peter G. Haines, Dean R. Malsbary, and Anne Scott Daughtrey. General Business for Economic Understanding, 11th ed. South-Western Publishing Company, 1976.
7. Emerly, Robert J., M. William Golder, Charles R. Skovira, Eds. Trade and Industrial Education Course of Study for Machine Shop Practice. Harrisburg, PA: The Pennsylvania State University, College of Education, Department of Vocational Education and Pennsylvania Department of Education, Bureau of Vocational Education, 1973.
8. Felker, C. A. and J. G. Bradley. Shop Mathematics, 5th ed. Encino, CA: Glencoe Publishing Company, Inc., 1976.
9. Feirer, John L. and Earl E. Tatro. Machine Tool Metalworking. New York, NY: McGraw Hill Book Company, Inc., 1961.
10. Johnson, Harold V. General-Industrial Machine Shop. Peoria, IL: Chas. A. Bennett Company, Inc., 1963.
11. Kimbrell, Grady and Ben S. Vineyard. Succeeding in the World of Work. Bloomington, IL: McKnight Publishing Company, 1975.
12. Krar, Stephen F. and J. William Oswald. Drilling Technology. Albany, NY: Delmar Publishers, 1977.

13. Krar, Stephen F. and J. William Oswald. Grinding Technology. Albany, NY: Delmar Publishers, 1974.
14. Krar, Stephen F. and J. William Oswald. Turning Technology-Engine and Turret Lathes. Albany, NY: Delmar Publishers, 1971.
15. Ludwig, Oswald A., William J. McCarthy and Victor E. Repp. Metalwork Technology and Practices, 6th ed. Bloomington, IL: McKnight Publishing Company, 1969.
16. Machine Shop, Part 1 (Workbook and Testbook). Sacramento, CA: State Department of Education, 1972.
(P.O. Box 271, Sacramento, CA 95802)
17. McCarthy, W. J. and R. E. Smith. Machine Tool Technology. Bloomington, IL: McKnight Publishing Company, 1968.
18. Machine Shop Job Sheet Series, West Virginia State Board of Vocational Education, Division of Vocational Education, Trade and Industrial Education Service, n.d.
19. Oberg, Eric and others. Holbrook L. Horton (Ed.) Machinery's Handbook, 20th ed. New York, NY: Industrial Press, Inc., 1975.
20. Olivo, C. Thomas and Thomas P. Olivo. Basic Mathematics Simplified. Albany, NY: Delmar Publishers, 1977.
21. Pennsylvania Industrial Arts Safety Guide. Harrisburg, PA: Pennsylvania Department of Education, Industrial Arts Association of Pennsylvania, 1978.
22. Porter, Harold W, Orville D. Lascoe, and Clyde A. Nelson. Machine Shop Operations and Setups, 3rd ed. Chicago, IL: American Technical Society, 1963.
23. Pritt, Alton and Michael M. Murphy (Eds.). Vocational Industrial Education Service: Machine Shop. Charleston, WV: West Virginia State Board of Education, Bureau of Vocational, Technical and Adult Education, 1966.
24. Stamass, George. Numerical Control (N/C) Instructional Course Student Manual. Pittsburgh, PA: Merit Machinery, Inc., Meritmatic Division, 1972.
25. U.S. Department of Labor, Employment and Training Administration. Dictionary of Occupational Titles, 4th ed. Washington, DC: U.S. Department of Labor, 1977.
26. U.S. Department of Labor, Manpower Administration. Occupational Outlook Handbook, 1978-79 ed. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, 1978.

27. Walker, John R. Machining Fundamentals. South Holland, IL:
Goodheart-Willcox Company, Inc., 1973.

B. Audio-Visual Materials

Singer Career Systems. Job Survival Skills Program. Rochester, NY:
Singer Education Division, 1973.

Distributor: Associated Educational Consultants, Inc.
North Allegheny Office & Research Park
McKnight and Pine Creek Roads
Pittsburgh, PA 15237

Part II - Other Resources

A. Texts/Reference Books

1. Abrasive Machining. Cleveland, OH: Grinding Wheel Institute, 1973 (booklet). (2130 Keith Building, Cleveland, OH 44115)
2. Anderson, James and Earl E. Tatro. Shop Theory, 5th ed. New York, NY: McGraw-Hill Book Company, Inc., 1968.
3. Armco Stainless Steels. Middletown, OH: Armco Steel Corporation, 1963.
4. Benchwork, Machine Shop Series. Albany, NY: Delmar Publishers, n.d.
5. Blueprint Reading for Machinists--Intermediate. Albany, NY: Delmar Publishers, 1971.
6. Blueprint Reading for Machinists--Advanced. Albany, NY: Delmar Publishers, 1972.
7. Burghardt, Henry D., Aaron Axelrod, and James Anderson. Machine Tool Operation, Part 1, 5th ed. New York, NY: Gregg/McGraw-Hill Book Company, Inc., 1959.
8. Burghardt, Henry D., Aaron Axelrod, and James Anderson. Machine Tool Operation, Part 2, 4th ed. New York, NY: Gregg/McGraw-Hill Book Company, Inc., 1960.
9. Burghardt, Henry D., Aaron Axelrod, and James Anderson. Machine Tool Operation, Workbooks 1 and 2. New York, NY: McGraw-Hill Book Company, Inc., n.d.
10. Carboloy Application Data. Detroit, MI: General Electric Co., Metallurgical Products Department, 1961.
11. Chacey, Caryl A. Drafting and Manual Programming for Numerical Control. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1980.
12. Colvin and Stanley. American Machinist's Handbook.
13. Dictionary of Technical Terms. Milwaukee, WI: The Bruce Publishing Company.
14. Dwight, Carlton. Reading Blueprints in the Machine Industries. New York, NY: McGraw-Hill Book Company, Inc.
15. Eaton and Free. Machine Shop Science and Mathematics. Peoria, IL: The Manual Arts Press.

16. Elementary Blueprint Reading--for Beginners in Machine Shop Practice. Albany, NY: Delmar Publishers, Inc., 1970.
17. Engine Lathe Work, Learners Manual. Columbus, OH: Ohio Department of Education, Division of Vocational Education, Ohio Trade and Industrial Education Service.
18. Fabrication of Stainless Steel, prepared by U.S. Steel Corporation.
19. Felker, C. A. Machine Shop Technology. Milwaukee, WI: The Bruce Publishing Company.
20. French and Svensen. Mechanical Drawing, 6th ed. New York, NY: McGraw-Hill Book Company, Inc.
21. French, Thomas E. and Charles J. Vierck. Engineering Drawing, 10th ed. New York, NY: McGraw-Hill Book Company, Inc., 1966.
22. General Industry Safety Orders. Sacramento, CA: California Division of Industrial Safety, n.d.
23. Giesecke, Frederick E. and others. Engineering Graphics. New York: The MacMillan Company, 1969.
24. Handbook of Cold Finished Bars. Pittsburgh, PA: Jones and Laughlin Steel Company.
25. Hobbs, Glenn M., James McKinney, and J. Ralph Dalzell. Practical Mathematics - Addition, Subtraction, Multiplication, Division (Lesson Text No. 1 in the Practical Mathematics Pamphlet Series). Chicago, IL: American Technical Society, 1968. (14 pamphlet series)
26. How to Get the Most Out of Your Turret Lathe. Cleveland, OH: The Warner and Swasey Company, n.d.
27. How to Run a Lathe (revised ed. 55). South Bend, IN: South Bend Lathe, Inc., 1958.
28. Ihne and Streeter. Machine Trades Blueprint Reading. Chicago, IL: The American Technical Society.
29. Johnson, James F. Applied Mathematics. Milwaukee, WI: The Bruce Publishing Company.
30. Johnson, Harold V. Manufacturing Processes - Metals and Plastics. Peoria, IL: Chas. A. Bennett Company, Inc., 1973. (809 W Detweiler Drive, Peoria, IL 61614)
31. Knight, Roy E. Machine Shop Projects. Bloomington, IL: McKnight Publishing Company, n.d.

32. Lathe Work, Machine Shop Series. Albany, NY: Delmar Publishers, Inc.
33. LeGrand, Rupert. American Machinist Handbook. New York, NY: McGraw-Hill Book Company, Inc.
34. Loschy, Bernard. Techniques of Barrel and Vibratory Finishing. St. Paul, MN: BJL Company, 1973. (544 Labore Road, St. Paul, MN 55117)
35. Machine Shop, Part 2 (Workbook and Testbook). Sacramento, CA: California State Department of Education, 1976.
36. Machine Shop, Part 3 (Workbook and Testbook). Sacramento, CA: California State Department of Education, 1976.
37. Machine Tool Metal Working. New York, NY: McGraw-Hill Book Company, Inc., 1971
38. Machine Trades I Learners Manual. Columbus, OH: Ohio Department of Education, Division of Vocational Education, Ohio Trade and Industrial Education Service.
39. Milling Machine Work. Albany, NY: Delmar Publishers, n.d.
40. Moltrecht, K. H. Machine Shop Practice, Vol. 2. New York, NY: Industrial Press, Inc., 1971.
41. Nicholson, Fred (Ed.), Henry Ford Trade School. Shop Theory, 4th ed. New York, NY: McGraw-Hill Book Company, Inc., 1955.
42. Palmer and Bibb. Practical Mathematics. New York, NY: McGraw-Hill Book Company, Inc.
43. Palmer, Frank R. and George V. Lverssen. Tool Steel Simplified. Reading, PA: Carpenter Steel Company.
44. Rusinoff. Manufacturing Processes Materials and Production. Chicago, IL: American Technical Society.
45. Slade, Samuel, Louis Margolis, and John G. Boyce. Mathematics for Technical and Vocational Schools, 5th ed. New York, NY: John Wiley and Sons, Inc., 1968. (605 Third Avenue, New York, NY 10016)
46. Shuman. Machine Shop Work. Chicago, IL: American Technical Society.
47. Smith, Robert. Mathematics for Machine Technology. Albany, NY: Delmar Publishers, 1974.

48. Stainless Steel Handbook. Pittsburgh, PA: Allegheny Ludlum Steel Corporation.
49. Taylor, David L. Drill Press Work. Albany, NY: Delmar Publishers, 1980.
50. Tool Steel Handbook. Pittsburgh, PA: Allegheny Ludlum Steel Corporation.
51. Wagner and Arthur. Machine Shop Theory and Practice. New York: D. Van Nostrand Company, Inc.
52. Wolfe and Phelps. Practical Shop Mathematics. New York, NY: McGraw-Hill Book Company, Inc.

B. Audio-Visual Aids

1. A list of instructional aids appears in Machine Shop
(Vocational Industrial Education Service, Alton Pritt and Michael M. Murphy, Eds.), Charleston, WV: West Virginia State Board of Education, Bureau of Vocational, Technical and Adult Education. (Available from The West Virginia Vocational Curriculum Laboratory.)

Shown on pages 29 through 32 are instructional aids for the following areas of instruction:

- Drilling Machines or Drillpress Operations
- Engine Lathe Operations
- Forging and Heat Treating
- Hand Tools and Bench Work
- Linear Measurements
- Milling Machine
- Shaper
- Tool Room Procedures

The suggested aids include the following which are among those available from the West Virginia University Film Library:

- Care and Use of Drill Press
- Cutting a Keyway on Ends of Finished Shaft
- Cutting Keyways
- Cutting a Taper with Compound Rest and with Taper Attachment
- Demonstration Dividing Head; Plain Indexing and Cutting a Spur Gear

Diameters #2
 Machining a Cast Iron Block - Rectangular Block
 Machining a Tool Steel Block
 The Metal Working Lathe
 The Micrometer
 Milling Machine with Wall Charts
 Rough Turning Between Centers
 The Steel Rule
 Straddle and Surface Milling to Close Tolerances
 Turning a Taper with Tailstock Offset

2. Audio-visual materials are suggested for units of instruction on measurement, blueprint reading, bench work, power saws, and engine lathes in Machine Shop: Competency-Based Education Curriculum (Hubert Bohlmann, McKinley Vocational-Technical Center, Wheeling, for West Virginia State Department of Education, Bureau of Vocational-Technical and Adult Education, 1975):

- a. The Jam Handy Organization
 2821 E. Grand Blvd.
 Detroit, MI 48211

Measurement, Part 1 (film strip)
Measurement, Part 2 (film strip)

- b. Learning Lab

Laying Out (film loop)

- c. McGraw-Hill, Inc.

Carriage and Feed Operators (film loop)
Power Train (film loop)
Using the Hacksaw (film loop)

3. Films:

- a. Association Films
 Western Area Exchange
 25358 Cypress Avenue
 Hayward, CA 94544

The Cutting Edge (16 mm sound film produced by
 the Norton Company)

- b. Federal Products Corporation
Providence, RI

Dial Indicators and Dial Indicator Gauges
(16 mm sound film)

- c. Government Films Division
United World Films, Inc.
1445 Park Avenue
New York, NY

Principles of Lubrication
(16 mm sound film prepared by U.S. Office of
Education; available for purchase)

- d. The Jam Handy Organization
2821 East Grand Boulevard
Detroit, MI 48211

Machining Stainless Steels, Parts I and II
(16 mm film)
Lathes, Part I, Kit C, Film 4, "Introduction to
Machining" (slidefilm)
Scraping, Film 6, Benchwork Kit (slidefilm)
Specialized Machines--Turret Lathes, Kit C, Film 9,
"Introduction to Machining" (slidefilm)

- e. L. S. Starrett Company
Athol, MA

The Tools and Rules for Precision Measurement
(16 mm sound film)

- f. Public Relations Film Library
General Motors Corporation
1 - 101 General Motors Building
Detroit, MI 48202

ABC's of Hand Tools (16 mm sound film)

- g. San Francisco Film Distribution Center

Rhapsody of Steel
(prepared by United States Steel Co.)

- h. Warner and Swasey Co.
Cleveland, OH

Chips (16 mm sound film)

APPENDIX A
RESPONSES TO VALIDATION SURVEY

APPENDIX A-1

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS
1978

Background Data	All Respondents (N=100)
	%
1. Sex	
Male	97
Female	2
2. Time Spent on Present Job	
1-5 Years	34
6-10 Years	28
11-20 Years	22
21-58 Years	16
3. Years Spent in Career Field	
1-5 Years	12
6-10 Years	8
11-15 Years	9
16-20 Years	11
21-30 Years	30
31-40 Years	21
41 Years or Over	9
4. Present Position by Job Title	
1. President/Vice President	7
2. Owner	5
3. Teacher/Instructor/Professor	35
4. Superintendent/Supervisor	13
5. Machinist	20
6. Manager	6
7. Foreman	8
8. Sales	1

APPENDIX A-2

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY LOCATION - 1978

1 = Never
2 = Seldom
3 = Sometimes
4 = Often

Tasks	West Virginia N = 48				Pennsylvania N = 52			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
A. PERFORMING SUPERVISORY FUNCTIONS								
1. Coordinate workers with work to done	21	15	12	46	13	0	4	79
2. Determine availability of supplies and materials. Maintain files and order and receive stock	25	10	15	44	13	6	8	69
3. Follow-up on end product quality control standards	23	4	25	42	15	2	23	56
4. Supervise machine use and operation	21	6	8	58	17	2	6	71
5. Supervise maintenance of shop safety equipment, safe operations, and set up of machinery	21	2	12	58	13	4	4	75
6. Inventory supplies and materials	27	15	19	35	11	10	27	48
B. PERFORMING MATHEMATICAL CALCULATIONS								
1. Apply dimensions of parts from blueprints or specifications to job	4	6	17	71	10	6	11	69
2. Calculate amount of material to be removed to obtain correct limits for rework	17	8	19	54	10	11	29	46
3. Calculate change gearing for threading	25	27	27	17	36	31	19	11
4. Calculate conversion of revolutions per minute (RPM) to surface feet per minute (SFPM)	21	19	31	25	23	4	33	36
5. Calculate dimensions of slots and grooves on special setups	23	25	35	12	17	11	46	21
6. Calculate gear blank specifications for indexing	27	27	29	12	42	19	27	10
7. Calculate machine speeds and feeds by formulas	29	25	19	25	27	4	19	46
8. Calculate stock utilization in machine work	21	4	29	44	19	6	29	44
9. Calculate tolerances or allowances for proper fits	12	4	21	58	15	11	21	48
10. Convert to metric measurement	27	29	29	10	33	25	35	6

APPENDIX A-2

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS
BY LOCATION - 1978 (Continued)

Tasks	West Virginia N = 48				Pennsylvania N = 52			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
11. Determine clearance, relief and rake of cutting tools	17	12	17	50	19	11	21	44
12. Determine material strength according to standard raw stock sizes	48	25	17	8	52	23	8	15
13. Take micrometer readings	2	4	8	81	10	8	10	69
14. Use machining handbooks, charts and tables to aid in mathematical calculations	12	6	19	58	6	6	25	60
C. DESIGNING AND PLANNING MACHINE WORK								
1. Make sketches of parts to be machined	8	4	23	60	8	11	25	52
2. Perform layout for precision machine work using layout instruments	19	4	29	44	13	10	19	54
3. Perform layout for precision machine work using milling machine	25	15	23	33	21	8	29	38
4. Inspect, remove and replace part(s) for repair or machine work	10	12	37	37	17	15	29	35
5. Refer to technical orders, standards and specifications for machine work	15	10	33	40	15	10	23	48
6. Test for hardness	42	27	19	10	25	19	27	25
D. PERFORMING METALWORK OPERATIONS								
1. Clamp work in holding device	4	4	15	73	10	8	19	60
2. Cut metal stock	4	4	17	71	11	6	10	69
3. Fabricate special metal-working tools	19	19	27	31	15	11	40	31
4. Heat treat metal	29	27	17	25	25	23	25	25
5. Operate cylindrical grinder	65	8	17	8	38	15	21	23
6. Operate hone	67	23	6	2	35	27	21	15
7. Perform bench filing	19	15	31	31	13	11	27	46
8. Polish metal	17	15	25	40	13	13	27	42
9. Using depth gages	15	15	31	35	6	8	29	54
10. Measure with dial test indicator	6	15	12	62	11	8	15	63
11. Check layout with gage blocks	56	15	21	6	13	23	29	33
12. Determine accuracy of precision measurement instruments with gage blocks	46	12	21	17	13	15	33	35
13. Measure with height gages	29	21	33	12	10	10	29	48
14. Measure with sine bar	67	21	6	4	15	33	33	17

APPENDIX A-2

MACHINE SHOP

 REVALIDATION SURVEY OF INCUMBENT WORKERS
 BY LOCATION - 1978 (Continued)

Tasks	West Virginia N = 48				Pennsylvania N = 52			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
E. PERFORMING BENCH WORK								
1. Cut materials with hand hacksaws	12	23	33	29	8	23	33	33
2. Cut threads with hand taps	6	8	37	44	8	8	23	58
3. Cut threads with dies	8	15	31	42	8	11	31	46
4. Disassemble and assemble parts	8	12	40	35	11	13	23	50
5. Hone and lap surfaces	60	15	10	12	21	25	33	17
6. Hand sharpen cutting tools with abrasive stones	12	6	23	52	11	19	31	36
7. Ream holes with hand reamers	19	19	33	25	11	25	25	35
8. Remove and replace helical coil wire screw thread insert (STI)	58	15	21	4	29	38	23	8
9. Remove damaged screws and other non-hardened threaded hardware	21	17	29	29	17	21	35	23
10. Work and shape metal	23	8	21	46	25	10	19	44
F. OPERATING DRILL PRESSES								
1. Center punch hole location	10	4	10	71	13	10	13	60
2. Consider material of workpiece to be drilled	19	2	17	58	11	10	15	61
3. Counterbore to depth specified in blueprint	12	10	35	35	8	8	17	63
4. Countersink hole to drawing requirements	12	15	31	35	10	8	17	63
5. Determine holding technique	19	0	21	54	11	11	6	69
6. Drill hole to size	6	0	8	79	8	8	6	75
7. Mount and secure work in holding device	8	0	12	73	8	6	10	73
8. Ream hole to size	12	15	27	40	10	8	11	67
9. Sharpen drill using grinding wheel	10	2	15	67	10	10	21	58
10. Sharpen drill bit free hand against grinding wheel and check for sharpness	8	2	17	67	8	15	23	50
11. Select tool or cutter for drill press operation	8	2	17	67	10	11	6	69
12. Secure tool or cutter in drill press spindle	10	4	17	62	10	10	6	71
13. Select sleeve to suit drill	8	2	8	75	11	8	8	69
14. Set drill press for proper feeds and speeds for operation performed	6	6	12	69	13	6	8	69
15. Spot-face workpiece	27	19	25	23	19	17	19	42

APPENDIX A-2

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS
BY LOCATION - 1978 (Continued)

Tasks	West Virginia N = 48				Pennsylvania N = 52			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
16. Use tapping attachment to tap hole	42	17	19	17	11	11	33	40
17. Hand tap hole to blueprint specifications	10	2	33	48	11	15	19	52
18. Use automatic feed on drill press	25	6	21	42	19	13	15	48
G. OPERATING GRINDING MACHINES								
1. Attach and align materials for grinding operations	25	8	40	25	13	13	15	54
2. Balance grinding wheel	52	10	17	17	27	25	19	27
3. Cut off or part materials with grinding machines	60	15	8	15	23	27	33	15
4. Dress and true grinding wheels	10	6	27	52	13	8	15	60
5. Inspect grinding wheels	12	6	17	58	13	13	15	56
6. Measure, inspect and rework workpiece on grinding machines	27	17	27	27	19	10	19	50
7. Perform grinding machine operations as per setup	33	10	21	31	17	11	10	60
8. Polish with grinding machine	56	19	6	15	40	25	13	19
9. Select and set speeds and feeds of power feed grinders	44	19	10	23	35	8	19	37
10. Set up and perform surface grinding operations	25	17	19	37	19	10	13	54
11. Set up grinder and sharpen plain milling cutters	50	19	15	15	25	25	19	29
12. Set up, grind and sharpen pre-shaped lathe tools	52	12	8	25	27	23	17	31
13. Set up grinder and shape chisels	60	21	6	10	40	17	21	19
14. Set up grinder to run workpiece between centers	50	12	12	21	33	23	17	25
15. Set up grinder to run on magnetic chuck	44	10	21	23	21	11	10	56
16. Use utility grinder	27	17	19	33	21	13	21	42
H. OPERATING LATHES								
1. Align lathe centers using approximate method	19	15	25	37	21	19	25	31
2. Align lathe centers using accurate measurement	15	8	23	50	15	17	13	50
3. Bore holes with lathe	8	4	19	65	11	13	10	61
4. Counterbore holes with lathe	12	12	19	52	10	11	10	65
5. Countersink holes using lathe	17	10	27	42	10	15	25	46

APPENDIX A-2

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS
BY LOCATION - 1978 (Continued)

Tasks	West Virginia N = 48				Pennsylvania N = 52			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
6. Using taper attachment, cut long external tapered surfaces	12	25	29	31	17	15	25	38
7. Using compound rest, cut short external tapered surfaces	12	10	37	37	13	13	19	50
8. Cut internal threads with lathe	15	10	25	48	13	17	21	44
9. Cut external threads with lathe	10	4	19	62	10	10	21	56
10. Cut internal tapered surfaces	23	21	31	23	19	19	31	27
11. Die cut threads with lathe, hand threading	35	21	21	19	11	19	38	27
12. Die cut threads with lathe using die heads	44	25	12	15	21	23	27	25
13. Drill holes with lathe	6	2	23	65	13	10	10	63
14. Set up lathe and face work-piece held in a chuck	8	2	10	75	15	4	11	65
15. Measure stock	8	2	12	73	13	4	6	75
16. Perform contour, angular or radii cuts with lathe	17	12	21	46	15	13	21	48
17. Perform lathe filing	6	10	21	58	15	10	13	58
18. Perform lathe filing to deburr part	10	8	25	52	15	10	11	60
19. Perform spinning operation using forming tool	56	17	8	17	48	11	15	23
20. Ream holes with lathe	19	15	33	31	17	13	11	54
21. Retrace threads on lathe	10	12	33	40	17	17	31	31
22. Rough cut and finish cut with lathe	6	2	6	81	10	10	2	75
23. Knurl parts with lathe	10	23	35	29	13	19	29	35
24. Secure tool holder, fixtures or attachments	6	0	23	67	11	8	6	71
25. Select and set speeds and feeds	4	0	6	85	11	8	6	71
26. Set up engine lathe	8	4	2	81	13	11	6	65
27. Set up turret lathe for operations	60	4	12	19	29	19	15	35
28. Tap threads with lathe	15	17	37	27	15	10	27	44
29. Set up tool post grinder	27	23	23	25	25	21	33	19
30. Perform grinding operation	29	17	29	23	27	23	27	17
1. OPERATING MILLING MACHINES								
1. Align milling machine fixtures	12	12	37	33	10	15	19	54
2. Align milling machine attachments	19	6	40	33	10	11	21	56
3. Assemble completed mill work	21	15	35	25	19	10	23	46
4. Bore holes with milling machines	17	19	29	33	10	13	35	38
5. Bore to finish bushing	23	17	23	36	21	15	25	35

APPENDIX A-2

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY LOCATION - 1978 (Continued)

Tasks	West Virginia N = 48				Pennsylvania N = 52			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
6. Bore to remove bushings	35	21	19	23	31	17	27	21
7. Cut external keyway	12	10	19	54	15	19	23	38
8. Drill holes with milling machine	17	17	29	33	11	8	33	46
9. Duplicate on the profile milling machine	75	12	2	8	58	21	10	10
10. Inspect completed mill work	23	6	25	44	13	10	11	63
11. Mill an angle	10	15	33	37	11	8	21	58
12. Mill an external radius	33	21	25	17	17	15	38	27
13. Mill cylindrical work	42	12	17	27	23	15	31	29
14. Mill gears	23	29	31	12	40	21	23	13
15. Mill internal slots using slotter and attachments	52	25	17	4	35	31	25	8
16. Perform end milling	12	6	19	58	11	8	6	73
17. Perform flycutting operations	19	19	27	31	13	11	23	46
18. Perform form milling	33	25	23	17	17	17	35	27
19. Perform reaming operations	33	21	15	29	15	13	29	36
20. Perform cutting-off operations	29	35	17	17	25	19	31	21
21. Perform straddle milling opera- tions on the horizontal mill	29	33	27	8	21	17	36	23
22. Select and set speeds and feeds for milling work	8	2	23	62	13	4	10	69
23. Square up metal using dividing head	29	19	27	21	27	15	40	15
24. Square up metal using table vise	10	17	23	44	11	10	17	60
J. OPERATING POWER SAWS								
1. Cut and weld bandsaw blades to insert for contour sawing	23	17	23	33	17	11	23	44
2. Measure material and cut off material with power hack saw	12	10	8	67	17	10	13	56
3. Determine type of material to be sawed	15	8	19	56	15	6	25	50
4. Remove and replace saw blades	6	10	23	56	11	8	17	60
5. Sawing with metal band saw to scribed lines	17	10	25	44	15	13	11	58
6. Select and set speeds and feeds for sawing operations	15	10	15	56	15	6	17	58
7. Select appropriate blades	12	10	25	48	13	6	23	54

APPENDIX A-2

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS
BY LOCATION - 1978 (Continued)

Tasks	West Virginia N = 48				Pennsylvania N = 52			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
K. OPERATING PRESSES								
1. Set up and punch materials with press	67	12	8	10	46	15	17	19
2. Select accessories and attachments for press work	46	17	12	23	48	8	17	23
3. Set up press and assemble parts with presses	27	29	12	27	46	8	25	17
4. Set up press and disassemble parts with presses	25	29	15	27	42	11	23	19
5. Straighten miscellaneous parts with presses	25	23	27	21	33	17	29	15
6. Set up, remove and replace parts with presses	29	12	31	25	35	11	33	15
L. OPERATING SHAPERS								
1. Align shaper attachment, work-piece and cutting tool	23	6	35	33	25	13	23	33
2. Select and set speeds and feeds of shapers	23	8	31	35	27	15	19	35
3. Select, shape and sharpen cutting tools for shaper operation	29	6	27	33	35	13	21	29
M. PERFORMING PRODUCTION MACHINIST LINE WORK								
1. Remove and install pins	46	19	15	19	35	11	23	29
2. Remove defective splines and replace with new splines	58	15	10	15	48	13	19	15
3. Remove frozen or seized parts	40	21	10	27	25	29	29	13
N. MAINTAINING MACHINES AND TOOLS								
1. Inspect and change drive pulleys or belts	15	29	27	25	17	21	35	23
2. Clean and store hand tools, cutters, fixtures, jigs or attachments	10	12	17	56	15	11	31	38
3. Install, level and fasten down machines	23	31	23	19	25	17	35	21
4. Remove machine parts	10	25	29	31	19	15	36	25
5. Replace and adjust machine parts	12	21	23	40	17	17	38	23
6. Inspect and remove, replace or adjust machine guards	15	25	23	33	21	11	36	27
7. Scrape and paint machines	40	29	12	17	27	33	21	15
8. Inspect and repair hand tools	12	21	27	37	19	15	33	29

APPENDIX A-2

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS
BY LOCATION - 1978 (Continued)

Tasks	West Virginia				Pennsylvania			
	N = 48				N = 52			
	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%
9. Store grinding wheels	29	21	19	29	15	25	21	36
10. Store precision tools	15	12	15	55	15	11	21	50
11. Perform maintenance on lathe	17	10	23	46	19	13	27	36
12. Perform maintenance on milling machine	17	12	31	35	19	15	27	36
13. Perform maintenance on drill press	15	15	33	33	19	13	27	36
14. Perform maintenance on grinder	15	12	35	33	23	13	25	36
15. Perform maintenance on band saw	17	19	29	31	19	11	29	38
16. Select coolants, cutting oils or compounds for machining operation	19	10	27	40	19	13	27	36
17. Clean arbor presses	40	17	19	21	35	19	23	21
18. Lubricate arbor press	42	19	15	21	29	21	21	25
19. Clean hydraulic press	44	17	15	21	42	13	19	21
20. Lubricate hydraulic presses	48	12	12	23	48	8	23	19
21. Inspect arbor presses for safe operational condition	44	10	15	29	35	10	19	33
22. Inspect hydraulic press for safe operational condition	37	8	15	33	40	11	11	33
23. Perform maintenance on power hacksaw	31	15	15	38	29	11	29	25
24. Inspect work area for safe working environment	12	8	10	42	23	4	10	46
O. MAINTAINING SHOP FACILITIES AND WORK AREAS								
1. Dispose of scrap metal, chips or shavings and trash or waste materials	21	8	8	56	21	4	15	56
2. Perform custodial tasks	31	6	6	50	29	11	21	36
3. Clean and maintain work and adjacent work areas	21	12	15	48	19	10	21	48
4. Paint facilities	42	17	15	23	33	19	25	19
5. Sweep and clean shop facility	37	4	8	46	25	6	10	56
P. OPERATING NUMERICAL CONTROL N/C MACHINES								
1. Transfer drawing to tape	67	12	4	12	61	6	10	21
2. Turn with N/C machine	71	15	2	8	56	8	10	25
3. Mill with N/C machine	73	12	4	6	54	8	11	25
4. Drill with N/C machine	73	12	2	8	52	10	8	29
Q. OPERATING ELECTRICAL DISCHARGE MACHINE (EDM)								
1. Set up for EDM operation	75	12	8	2	46	17	17	17

APPENDIX A-3

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978

1 = Never
 2 = Seldom
 3 = Sometimes
 4 = Often

Tasks	1 - 5 Years N = 5				6 - 10 Years N = 8				Over 10 Years N = 80			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
A. PERFORMING SUPERVISORY FUNCTIONS												
1. Coordinate workers with work to be done	40	20	0	20	37	0	0	50	11	6	10	69
2. Determine availability of supplies and materials. Maintain files and order and receive stock	60	0	20	0	37	0	12	37	12	9	11	64
3. Follow-up on end product quality control standards	40	0	0	40	25	0	25	37	14	4	27	51
4. Supervise machine use and operation	20	20	20	20	37	0	12	37	14	2	6	74
5. Supervise maintenance of shop safety equipment, safe operations, and set up of machinery	20	0	0	60	37	0	0	50	11	4	9	72
6. Inventory supplies and materials	60	0	20	0	37	12	12	37	11	12	26	46
B. PERFORMING MATHEMATICAL CALCULATIONS												
1. Apply dimensions of parts from blueprints or specifications to job	0	0	40	60	0	0	0	87	5	6	15	71
2. Calculate amount of material to be removed to obtain correct limits for rework	20	0	0	80	12	0	25	50	7	12	26	51
3. Calculate change gearing for threading	40	20	20	20	12	12	25	25	27	34	25	12
4. Calculate conversion of revolutions per minute (RPM) to surface feet per minute (SFPM)	60	0	0	40	12	0	37	25	15	14	36	32
5. Calculate dimensions of slots and grooves on special setups	40	20	40	0	12	0	37	25	14	21	45	17

APPENDIX A-3

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978
(Continued)

Tasks	1 - 5 Years N = 5				6 - 10 Years N = 8				Over 10 Years N = 80			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
6. Calculate gear blank specifications for indexing	60	40	0	0	12	25	37	12	30	24	31	12
7. Calculate machine speeds and feeds by formulas	60	20	0	20	25	12	12	37	20	15	22	40
8. Calculate stock utilization in machine work	40	0	20	40	25	0	25	37	14	5	31	49
9. Calculate tolerances or allowances for proper fits	0	20	20	60	0	0	12	62	9	9	24	56
10. Convert to metric measurement	60	0	40	0	12	25	37	0	26	31	31	10
11. Determine clearance, relief and rake of cutting tools	40	0	0	60	25	0	25	25	10	15	21	51
12. Determine material strength according to standard raw stock sizes	80	20	0	0	50	12	12	12	44	27	14	14
13. Take micrometer readings	0	0	0	100	0	0	0	75	4	6	10	77
14. Use machining handbooks, charts and tables to aid in mathematical calculations	20	0	40	40	12	0	12	50	2	6	22	66
C. DESIGNING AND PLANNING MACHINE WORK												
1. Make sketches of parts to be machined	20	0	20	60	0	0	25	50	4	9	25	61
2. Perform layout for precision machine work using layout instruments	0	0	40	60	12	0	25	37	12	7	25	54
3. Perform layout for precision machine work using milling machine	60	0	20	20	25	0	0	50	16	12	31	39
4. Inspect, remove and replace part(s) for repair or machine work	40	0	60	0	12	12	25	37	10	15	34	40
5. Refer to technical orders, standards and specifications for machine work	40	0	20	40	25	0	12	50	7	12	32	46
6. Test for hardness	60	40	0	0	25	12	37	12	27	24	25	21

APPENDIX A-3

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 5				6 - 10 Years N = 8				Over 10 Years N = 80			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
D. PERFORMING METALWORK OPERATIONS												
1. Clamp work in holding device	0	0	20	80	0	0	12	62	5	7	16	70
2. Cut metal stock	20	0	20	60	0	0	0	75	4	6	12	76
3. Fabricate special metalworking tools	40	40	20	0	12	0	25	37	11	15	39	34
4. Heat treat metal	60	40	0	0	37	25	12	12	19	25	25	30
5. Operate cylindrical grinder	40	20	20	20	50	0	12	25	49	12	21	16
6. Operate hone	60	20	0	20	50	12	25	0	46	27	15	10
7. Perform bench filing	40	40	20	0	12	0	25	37	10	11	32	45
8. Polish metal	60	0	20	20	0	12	37	25	10	15	27	46
9. Using depth gages	40	20	0	40	0	0	25	50	6	11	32	49
10. Measure with dial test indicator	20	20	20	40	0	0	12	62	4	11	15	69
11. Check layout with gage blocks	60	40	0	0	50	0	25	12	26	20	29	24
12. Determine accuracy of precision measurement instruments with gage blocks	20	0	60	20	37	0	25	12	25	16	27	30
13. Measure with height gages	20	20	40	20	12	0	37	25	17	16	30	35
14. Measure with sine bar	60	20	20	0	50	12	25	0	34	30	21	14
E. PERFORMING BENCH WORK												
1. Cut materials with hand hacksaws	20	20	60	0	37	0	25	25	5	26	31	36
2. Cut threads with hand taps	0	0	60	40	0	0	25	50	5	9	29	56
3. Cut threads with dies	0	40	40	20	0	0	12	62	6	12	32	47
4. Disassemble and assemble parts	20	0	60	20	12	0	12	50	6	14	31	47
5. Hone and lap surfaces	80	0	0	20	50	0	12	25	34	24	26	15
6. Hand sharpen cutting tools with abrasive stones	0	20	40	40	0	0	37	37	9	14	26	49
7. Ream holes with hand reamers	40	40	20	0	12	0	25	37	10	24	31	34
8. Remove and replace helical coil wire screw thread insert (STI)	80	20	0	0	37	12	25	12	36	31	25	6
9. Remove damaged screws and other non-hardened threaded hardware	60	0	20	20	12	12	25	25	11	22	36	29
10. Work and shape metal	40	0	40	20	12	12	50	12	17	10	17	54

APPENDIX A-3

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 5				6 - 10 Years N = 8				Over 10 Years N = 80			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
F. OPERATING DRILL PRESSES												
1. Center punch hole location	40	20	20	20	12	0	0	75	7	6	11	72
2. Consider material of workpiece to be drilled	20	0	0	80	25	0	0	62	10	6	17	64
3. Counterbore to depth specified in blueprint	20	20	20	40	12	0	12	50	6	9	27	55
4. Countersink hole to drawing requirements	20	20	20	40	12	0	12	50	6	11	25	55
5. Determine holding technique	20	0	0	80	12	0	0	62	10	6	15	66
6. Drill hole to size	0	0	20	80	0	0	0	75	5	4	5	84
7. Mount and secure work in holding device	20	0	0	80	0	0	0	75	5	2	11	79
8. Ream hole to size	20	20	60	0	12	0	0	62	6	11	19	61
9. Sharpen drill using grinding wheel	20	20	0	60	0	0	25	50	6	5	17	69
10. Sharpen drill bit free hand against grinding wheel and check for sharpness	20	0	0	80	0	0	12	62	5	10	21	61
11. Select tool or cutter for drill press operation	20	0	20	60	0	0	0	75	5	7	11	74
12. Secure tool or cutter in drill press spindle	20	0	20	60	0	0	0	75	6	7	11	72
13. Select sleeve to suit drill	20	0	0	80	0	0	0	75	6	5	9	77
14. Set drill press for proper feeds and speeds for operation performed	0	20	20	60	0	0	0	75	7	5	10	75
15. Spot-face workpiece	80	0	20	0	0	25	0	50	17	19	25	36
16. Use tapping attachment to tap hole	20	40	40	0	12	25	12	25	26	10	27	34
17. Hand tap hole to blueprint specifications	20	0	40	40	0	0	12	62	7	9	27	54
18. Use automatic feed on drill press	20	20	60	0	0	0	12	62	21	10	16	50
G. OPERATING GRINDING MACHINES												
1. Attach and align materials for grinding operations	20	0	20	60	12	0	37	37	16	12	29	41
2. Balance grinding wheel	40	20	20	20	37	0	25	12	35	20	19	25
3. Cut off or part materials with grinding machines	80	0	20	0	62	0	12	12	35	25	22	16

APPENDIX A-3

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 5				6 - 10 Years N = 8				Over 10 Years N = 80			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
4. Dress and true grinding wheels	0	0	40	60	12	0	25	37	10	7	20	61
5. Inspect grinding wheels	40	0	0	60	12	0	12	50	7	11	17	61
6. Measure, inspect and rework workpiece on grinding machines	20	20	40	20	25	0	12	50	19	14	25	41
7. Perform grinding machine operations as per setup	40	0	20	40	0	0	25	50	21	12	15	50
8. Polish with grinding machine	80	20	0	0	37	0	12	25	45	25	11	17
9. Select and set speeds and feeds of power feed grinders	60	0	40	0	25	0	0	50	35	16	16	31
10. Set up and perform surface grinding operations	40	20	20	20	12	0	25	50	16	14	16	51
11. Set up grinder and sharpen plain milling cutters	80	20	0	0	25	0	12	50	30	26	20	22
12. Set up, grind and sharpen preshaped lathe tools	60	0	0	40	50	0	12	25	31	22	15	30
13. Set up grinder and shape chisels	80	20	0	0	25	12	25	25	46	21	15	16
14. Set up grinder to run workpiece between centers	80	0	20	0	12	12	12	37	36	21	16	25
15. Set up grinder to run on magnetic chuck	60	0	20	20	12	12	25	37	27	11	15	45
16. Use utility grinder	20	40	20	20	0	12	0	62	20	15	24	40
H. OPERATING LATHES												
1. Align lathe centers using approximate method	40	20	20	20	25	0	0	50	16	19	27	36
2. Align lathe centers using accurate measurement	60	0	0	40	0	0	12	62	11	14	20	54
3. Bore holes with lathe	0	0	40	60	12	0	0	62	7	9	14	69
4. Counterbore holes with lathe	20	20	40	20	12	0	0	62	7	11	14	66
5. Countersink holes using lathe	20	20	40	20	12	0	12	50	10	12	27	49
6. Using taper attachment, cut long external tapered surfaces	20	20	20	40	25	0	12	50	10	22	30	36

APPENDIX A-3

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 5				6 - 10 Years N = 8				Over 10 Years N = 80			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
7. Using compound rest, cut short external tapered surfaces	0	0	60	40	25	0	12	50	11	12	27	4
8. Cut internal threads with lathe	40	20	20	20	25	0	12	50	7	15	25	5
9. Cut external threads with lathe	0	20	40	40	12	0	12	50	7	6	19	66
10. Cut internal tapered surfaces	40	20	20	20	25	12	12	37	16	21	35	26
11. Die cut threads with lathe, hand threading	40	0	40	20	25	12	12	25	19	22	32	25
12. Die cut threads with lathe using die heads	60	20	20	0	12	25	0	37	29	26	22	21
13. Drill holes with lathe	0	0	20	80	25	0	0	50	7	6	15	70
14. Set up lathe and face workpiece held in a chuck	0	20	0	80	12	0	0	62	10	2	10	76
15. Measure stock	0	0	0	100	12	0	0	62	7	4	9	79
16. Perform countour, angular or radii cuts with lathe	40	20	20	20	12	0	12	50	11	14	21	52
17. Perform lathe filing	0	40	20	40	12	0	12	50	10	9	16	64
18. Perform lathe filing to deburr part	0	20	20	60	12	0	0	62	12	9	17	60
19. Perform spinning operation using forming tool	80	0	0	20	37	0	0	50	47	17	15	19
20. Ream holes with lathe	40	0	20	40	37	0	12	37	11	16	24	47
21. Rechase threads on lathe	40	20	40	0	0	12	12	50	10	15	35	39
22. Rough cut and finish cut with lathe	0	0	0	100	0	0	0	75	7	6	2	82
23. Knurl parts with lathe	20	20	60	0	12	12	12	50	9	21	34	35
24. Secure tool holder, fixtures or attachments	0	0	20	80	0	0	0	75	9	4	14	72
25. Select and set speeds and feeds	0	0	0	100	0	0	0	75	6	4	5	84
26. Set up engine lathe	20	40	0	40	0	0	0	75	9	6	4	80
27. Set up turret lathe for operations	60	0	20	20	25	0	25	25	41	15	12	30
28. Tap threads with lathe	20	0	40	40	0	0	37	37	12	15	32	39
29. Set up tool post grinder	40	40	20	0	37	12	12	25	19	24	31	25
30. Perform grinding operation	40	40	20	0	50	0	12	25	21	21	31	22

APPENDIX A-3

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 5				6 - 10 Years N = 8				Over 10 Years N = 80			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
I. OPERATING MILLING MACHINES												
1. Align milling machine fixtures	20	0	40	40	0	12	12	50	7	15	29	47
2. Align milling machine attachments	40	0	20	40	12	12	12	50	9	9	32	49
3. Assemble completed mill work	20	20	60	0	12	0	12	50	16	14	29	40
4. Bore holes with milling machines	20	40	20	20	12	12	12	50	10	15	35	39
5. Bore to finish bushing	40	20	20	20	12	25	25	25	19	15	25	40
6. Bore to remove bushings	60	20	20	0	12	25	25	25	30	20	24	25
7. Cut external keyway	40	40	0	20	0	0	25	50	9	16	22	51
8. Drill holes with milling machine	20	20	20	40	0	12	0	62	10	11	36	41
9. Duplicate on the profile milling machine	80	0	20	0	50	12	12	12	65	20	4	10
10. Inspect completed mill work	20	0	20	60	25	0	12	50	12	9	19	59
11. Mill an angle	20	40	20	20	0	12	12	50	7	9	29	54
12. Mill an external radius	40	40	20	0	12	25	12	25	21	16	36	25
13. Mill cylindrical work	40	20	20	20	12	12	25	37	30	14	25	30
14. Mill gears	80	0	20	0	0	25	37	12	27	29	27	15
15. Mill internal slots using slotter and attachments	60	40	0	0	37	37	0	12	39	29	25	6
16. Perform end milling	20	20	0	60	0	0	12	62	9	6	11	72
17. Perform flycutting operations	40	20	40	0	0	0	25	50	12	17	24	44
18. Perform form milling	60	20	20	0	25	0	37	25	19	25	30	25
19. Perform reaming operations	40	20	20	20	25	12	0	50	20	17	25	35
20. Perform cutting-off operations	40	40	20	0	25	25	12	25	24	28	26	21
21. Perform straddle milling operations or the horizontal mill	60	20	20	0	12	25	37	12	19	27	34	19
22. Select and set speeds and feeds for milling work	20	0	20	60	0	0	25	50	6	4	15	74
23. Square up metal using dividing head	60	20	20	0	12	25	25	25	22	17	37	20
24. Square up metal using table vise	20	0	40	40	0	0	12	62	7	15	19	56

APPENDIX A-3

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 5				6 - 10 Years N = 8				Over 10 Years N = 80			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
J. OPERATING POWER SAWS												
1. Cut and weld bandsaw blades to insert for contour sawing	60	0	20	20	12	12	0	50	15	15	26	42
2. Measure material and cut off material with power hack saw	20	0	0	80	25	0	12	50	11	10	11	66
3. Determine type of material to be sawed	20	0	20	60	25	0	12	50	10	7	24	57
4. Remove and replace saw blades	20	0	40	40	0	12	12	50	6	7	20	65
5. Sawing with metal band saw to scribed lines	40	20	0	40	0	0	0	75	11	12	21	54
6. Select and set speeds and feeds for sawing operations	40	0	20	40	12	0	0	62	10	9	17	62
7. Select appropriate blades	20	0	60	20	12	0	12	50	9	9	24	57
K. OPERATING PRESSES												
1. Set up and punch materials with press	60	20	20	0	50	0	12	25	54	15	14	16
2. Select accessories and attachments for press work	60	0	20	20	25	0	0	62	46	12	17	21
3. Set up press and assemble parts with presses	40	20	20	20	12	12	0	50	35	19	22	21
4. Set up press and disassemble parts with presses	60	0	20	20	12	12	0	50	31	21	22	22
5. Straighten miscellaneous parts with presses	20	20	40	20	0	25	12	37	29	21	30	17
6. Set up, remove and replace parts with presses	60	0	20	20	12	25	12	37	29	12	36	20
L. OPERATING SHAPERS												
1. Align ~~shaper~~ attachment, workpiece and cutting tool	40	0	40	20	25	12	12	37	17	11	32	36
2. Select and set speeds and feeds of shapers	40	0	60	0	25	25	0	37	19	12	27	40
3. Select, shape and sharpen cutting tools for shaper operation	60	0	40	0	25	0	12	50	25	12	26	34

APPENDIX A-3

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 5				6 - 10 Years N = 8				Over 10 Years N = 80			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
M. PERFORMING PRODUCTION MACHINIST LINE WORK												
1. Remove and install pins	40	60	0	0	25	12	12	37	37	12	22	26
2. Remove defective splines and replace with new splines	60	40	0	0	25	0	12	50	54	14	17	14
3. Remove frozen or seized parts	60	40	0	0	37	12	12	25	27	26	24	21
N. MAINTAINING MACHINES AND TOOLS												
1. Inspect and change drive pulleys or belts	20	20	40	20	0	25	37	12	15	25	31	27
2. Clean and store hand tools, cutters, fixtures, jigs or attachments	40	0	20	40	0	25	12	37	9	12	25	52
3. Install, level and fasten down machines	40	40	20	0	0	25	12	37	22	22	34	20
4. Remove machine parts	20	40	20	20	0	12	37	25	12	21	35	30
5. Replace and adjust machine parts	20	40	20	20	12	12	25	25	11	19	35	34
6. Inspect and remove, replace or adjust machine guards	40	40	0	20	12	12	0	50	16	17	36	29
7. Scrape and paint machines	60	40	0	0	25	25	0	37	30	32	20	16
8. Inspect and repair hand tools	20	40	40	0	25	25	0	37	12	16	34	36
9. Store grinding wheels	0	20	60	20	25	12	12	37	19	25	20	35
10. Store precision tools	0	20	20	60	12	12	12	37	11	11	20	56
11. Perform maintenance on lathe	40	20	0	40	12	12	0	50	15	11	30	42
12. Perform maintenance on milling machine	20	40	20	20	12	12	0	50	15	12	34	37
13. Perform maintenance on drill press	60	0	20	20	0	12	12	50	14	15	34	36
14. Perform maintenance on grinder	60	0	0	40	0	12	12	50	15	14	36	34
15. Perform maintenance on band saw	40	20	0	40	0	12	12	50	15	15	34	35
16. Select coolants, cutting oils or compounds for machining operation	20	0	40	40	12	12	12	37	16	12	30	40
17. Clean arbor presses	60	20	0	20	25	12	25	25	34	17	24	22
18. Lubricate arbor press	60	20	0	20	37	12	0	37	31	20	22	24
19. Clean hydraulic press	80	0	0	20	25	12	0	37	40	16	21	21
20. Lubricate hydraulic presses	80	0	0	20	37	0	12	25	44	11	21	22
21. Inspect arbor presses for safe operational condition	60	0	20	20	50	0	0	37	34	11	20	34

APPENDIX A-3

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY TOTAL TIME IN CAREER FIELD - 1978 (Continued)

Tasks	1 - 5 Years N = 5				6 - 10 Years N = 8				Over 10 Years N = 80			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
22. Inspect hydraulic press for safe operational condition	80	0	20	0	25	0	12	37	35	11	14	37
23. Perform maintenance on power hacksaw	40	20	20	20	25	0	0	62	26	15	25	31
24. Inspect work area for safe working environment	0	20	40	20	25	0	12	50	16	6	9	46
O. MAINTAINING SHOP FACILITIES AND WORK AREAS												
1. Dispose of scrap metal, chips or shavings and trash or waste materials	0	0	0	100	25	0	0	50	21	5	15	56
2. Perform custodial tasks	20	20	0	60	25	0	12	37	29	9	16	44
3. Clean and maintain work and adjacent work areas	20	0	20	60	25	0	0	50	17	12	20	49
4. Paint facilities	60	40	0	0	37	0	0	37	35	17	25	21
5. Sweep and clean shop facility	40	0	0	60	37	0	0	37	29	5	11	54
P. OPERATING NUMERICAL CONTROL N/C MACHINES												
1. Transfer drawing to tape	100	0	0	0	12	12	0	50	65	10	9	15
2. Turn with N/C machine	100	0	0	0	37	12	0	25	61	12	6	19
3. Mill with N/C machine	100	0	0	0	25	12	0	37	62	11	9	16
4. Drill with N/C machine	100	0	0	0	25	12	0	37	61	12	5	20
Q. OPERATING ELECTRICAL DISCHARGE MACHINE (EDM)												
1. Set up for EDM operation	60	0	20	20	50	0	25	12	59	19	11	10
									160			

APPENDIX A-4

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978

1 = Never
 2 = Seldom
 3 = Sometimes
 4 = Often

Tasks	Supervisors N = 39				Machinists N = 20				Instructors N = 35			
	1 %	2 %	3 %	4 %	1 %	2 %	3 %	4 %	1 %	2 %	3 %	4 %
A. PERFORMING SUPERVISORY FUNCTIONS												
1. Coordinate workers with work to be done	3	3	10	82	45	10	5	30	11	11	9	63
2. Determine availability of supplies and materials. Maintain files and order and receive stock	5	8	8	77	50	5	10	25	11	11	17	54
3. Follow-up on end product quality control standards	5	3	23	67	55	0	25	10	9	6	29	51
4. Supervise machine use and operation	5	3	13	77	55	5	10	20	9	6	0	80
5. Supervise maintenance of shop safety equipment, safe operations, and set up of machinery	3	5	13	77	55	0	0	35	6	3	9	77
6. Inventory supplies and materials	3	10	23	61	70	10	10	5	3	17	29	46
B. PERFORMING MATHEMATICAL CALCULATIONS												
1. Apply dimensions of parts from blue-prints or specifications to job	5	13	15	64	10	0	20	65	3	3	11	80
2. Calculate amount of material to be removed to obtain correct limits for rework	10	18	36	33	30	0	10	55	3	9	23	63
3. Calculate change gearing for threading	28	41	20	8	40	20	15	15	23	23	31	23
4. Calculate conversion of revolutions per minute (RPM) to surface feet per minute (SEPM)	20	15	44	18	50	10	15	15	6	9	29	54
5. Calculate dimensions of slots and grooves on special setups	15	26	41	15	50	10	25	5	6	17	49	26

APPENDIX A-4

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Supervisors N = 39				Machinists N = 20				Instructors N = 35			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
6. Calculate gear blank specifications for indexing	31	31	20	13	70	10	10	5	14	23	49	14
7. Calculate machine speeds and feeds by formulas	28	18	23	28	65	15	5	10	3	11	26	57
8. Calculate stock utilization in machine work	10	13	23	51	45	0	25	25	11	0	34	54
9. Calculate tolerances or allowances for proper fits	13	13	23	49	25	5	20	40	3	6	17	71
10. Convert to metric measurement	23	23	41	10	55	5	20	10	20	46	28	6
11. Determine clearance, relief and rake of cutting tools	18	20	28	31	35	10	5	40	3	3	17	74
12. Determine material strength according to standard raw stock sizes	49	13	13	23	75	10	10	0	34	43	14	9
13. Take micrometer readings	5	10	18	64	0	5	0	85	6	3	3	86
14. Use machining handbooks, charts and tables to aid in mathematical calculations	5	10	31	51	20	10	10	50	3	0	20	74
C. DESIGNING AND PLANNING MACHINE WORK												
1. Make sketches of parts to be machined	5	10	23	59	10	10	30	40	3	6	23	66
2. Perform layout for precision machine work using layout instruments	20	15	23	38	20	0	30	40	6	3	17	71
3. Perform layout for precision machine work using milling machine	23	18	26	31	40	0	20	30	9	11	29	49
4. Inspect, remove and replace part(s) for repair or machine work	18	18	26	36	20	10	40	25	3	14	37	43
5. Refer to technical orders, standards and specifications for machine work	13	10	20	54	30	15	20	30	6	9	40	43
6. Test for hardness	23	18	18	38	55	25	15	0	29	29	34	6

APPENDIX A-4

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Supervisors N = 39				Machinists N = 20				Instructors N = 35			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
D. PERFORMING METALWORK OPERATIONS												
1. Clamp work in holding device	8	15	15	59	0	0	25	65	6	0	14	77
2. Cut metal stock	10	10	15	61	5	0	25	60	3	3	6	86
3. Fabricate special metalworking tools	10	10	38	38	30	5	30	25	14	29	31	26
4. Heat treat metal	26	18	18	34	40	30	15	10	17	31	26	26
5. Operate cylindrical grinder	44	10	20	23	65	20	5	5	51	9	29	11
6. Operate hone	31	36	15	15	60	20	10	5	63	20	11	6
7. Perform bench filing	13	28	20	36	20	10	30	30	14	0	37	49
8. Polish metal	13	18	31	36	30	10	15	35	6	11	29	51
9. Using depth gages	3	13	36	46	20	10	25	35	7	11	29	49
10. Measure with dial test indicator	8	18	15	56	5	15	20	50	9	3	9	80
11. Check layout with gage blocks	26	20	20	31	40	30	15	10	40	14	34	11
12. Determine accuracy of precision measurement instruments with gage blocks	31	18	18	31	30	15	30	15	26	11	34	26
13. Measure with height gages	13	18	33	33	30	15	25	20	17	14	37	29
14. Measure with sine bar	26	28	23	20	55	30	10	0	46	28	17	9
E. PERFORMING BENCH WORK												
1. Cut materials with hand hacksaws	8	33	31	26	20	25	40	10	3	9	31	54
2. Cut threads with hand taps	5	13	31	49	10	5	45	30	3	3	23	69
3. Cut threads with dies	8	20	33	36	10	15	40	25	3	3	26	66
4. Disassemble and assemble parts	8	15	31	44	15	10	30	35	6	11	34	49
5. Hone and lap surfaces	23	18	28	28	55	25	10	5	49	23	17	9
6. Hand sharpen cutting tools with abrasive stones	8	20	31	36	5	10	35	40	17	6	20	57
7. Ream holes with hand reamers	8	20	28	41	35	30	15	10	9	20	40	29
8. Remove and replace helical coil wire screw thread insert (STI)	26	29	36	8	45	30	15	5	60	26	11	3
9. Remove damaged screws and other non-hardened threaded hardware	15	26	33	23	25	10	25	30	11	17	37	31
10. Work and shape metal	20	13	15	49	35	0	15	45	20	8	23	49

APPENDIX A-4

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Supervisors N = 39				Machinists N = 20				Instructors N = 35			
	1 %	2 %	3 %	4 %	1 %	2 %	3 %	4 %	1 %	2 %	3 %	4 %
F. OPERATING DRILL PRESSES												
1. Center punch hole location	8	10	18	59	25	5	15	50	6	3	6	83
2. Consider material of workpiece to be drilled	8	13	26	49	40	0	10	45	6	3	8	83
3. Counterbore to depth specified in blueprint	5	10	28	51	20	10	25	35	6	9	29	54
4. Countersink hole to drawing requirements	5	18	20	51	25	10	25	30	6	6	31	57
5. Determine holding technique	10	13	15	56	30	0	15	45	9	0	11	80
6. Drill hole to size	5	10	5	74	10	0	15	65	3	0	6	89
7. Mount and secure work in holding device	5	8	15	67	15	0	15	60	3	0	6	87
8. Ream hole to size	10	15	10	59	20	15	25	30	3	6	29	60
9. Sharpen drill using grinding wheel	5	10	18	61	20	5	15	50	6	3	20	71
10. Sharpen drill bit free hand against grinding wheel and check for sharpness	5	15	23	51	15	0	15	60	3	3	23	69
11. Select tool or cutter for drill press operation	8	10	10	67	15	5	20	50	3	3	9	83
12. Secure tool or cutter in drill press spindle	8	10	8	69	20	0	25	45	3	6	9	80
13. Select sleeve to suit drill	8	10	8	69	20	0	15	55	3	3	3	89
14. Set drill press for proper feeds and speeds for operation performed	8	8	10	69	20	10	15	45	3	3	6	86
15. Spot-face workpiece	15	18	15	46	50	15	20	5	14	23	29	34
16. Use tapping attachment to tap hole	8	15	33	38	20	20	35	15	49	11	14	23
17. Hand tap hole to blueprint specifications	8	18	26	44	15	0	35	40	8	6	20	66
18. Use automatic feed on drill press	13	10	15	56	40	15	20	15	17	9	20	51
G. OPERATING GRINDING MACHINES												
1. Attach and align materials for grinding operations	13	18	26	41	35	5	25	30	14	6	29	49
2. Balance grinding wheel	31	23	15	28	50	25	15	0	43	6	23	28
3. Cut off or part materials with grinding machines	28	28	18	23	55	15	20	5	46	14	26	14

APPENDIX A-4

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

	Supervisors N = 39				Machinists N = 20				Instructors N = 35			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
4. Dress and true grinding wheels	10	15	18	54	10	0	40	40	11	3	14	67
5. Inspect grinding wheels	8	18	15	56	20	0	15	50	11	6	14	69
6. Measure, inspect and rework workpiece on grinding machines	18	20	15	44	40	10	15	30	17	9	34	40
7. Perform grinding machine operations as per setup	20	15	15	46	45	5	10	30	17	9	17	57
8. Polish with grinding machine	36	33	8	20	60	20	5	5	51	11	17	20
9. Select and set speeds and feeds of power feed grinders	33	20	13	31	40	5	25	20	43	11	9	37
10. Set up and perform surface grinding operations	18	20	10	46	40	15	15	25	14	6	17	63
11. Set up grinder and sharpen plain milling cutters	26	13	28	31	55	30	0	10	37	29	17	17
12. Set up, grind and sharpen preshaped lathe tools	28	23	18	28	55	10	5	25	40	14	14	31
13. Set up grinder and shape chisels	44	20	15	18	70	15	0	10	43	20	20	17
14. Set up grinder to run workpiece between centers	28	23	13	33	60	25	0	5	45	6	26	23
15. Set up grinder to run on magnetic chuck	23	20	13	41	55	10	15	15	29	3	14	54
16. Use utility grinder	15	13	23	46	20	25	30	15	34	11	14	40
H. OPERATING LATHES												
1. Align lathe centers using approximate method	18	20	28	31	30	15	20	25	11	11	26	49
2. Align lathe centers using accurate measurement	10	23	15	49	30	5	25	30	9	6	14	69
3. Bore holes with lathe	5	15	10	68	20	5	25	40	6	6	14	71
4. Counterbore holes with lathe	5	15	10	67	25	15	10	40	6	9	23	60
5. Countersink holes using lathe	8	15	28	46	30	5	20	35	6	14	26	51
6. Using taper attachment, cut long external tapered surfaces	13	20	28	36	30	30	10	25	6	11	37	43

APPENDIX A-4

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Supervisors N = 39				Machinists N = 20				Instructors N = 35			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
7. Using compound rest, cut short external tapered surfaces	10	20	28	38	20	10	35	30	9	3	23	63
8. Cut internal threads with lathe	8	15	20	54	35	25	15	20	6	6	29	57
9. Cut external threads with lathe	5	10	20	61	20	10	40	20	6	0	6	86
10. Cut internal tapered surfaces	15	18	33	31	45	15	20	15	11	23	37	26
11. Die cut threads with lathe, hand threading	18	26	31	23	30	15	30	15	23	17	31	26
12. Die cut threads with lathe using die heads	26	26	23	23	45	20	15	10	31	26	20	20
13. Drill holes with lathe	5	15	13	64	15	0	25	50	6	0	14	77
14. Set up lathe and face workpiece held in a chuck	10	5	13	69	10	5	20	55	11	0	6	80
15. Measure stock	7	5	13	72	10	0	15	65	11	3	3	83
16. Perform contour, angular or radii cuts with lathe	5	23	18	51	40	5	15	30	11	9	29	51
17. Perform lathe filing	10	13	20	54	10	15	20	45	6	6	14	71
18. Perform lathe filing to deburr part	10	18	23	46	10	5	30	45	11	3	9	74
19. Perform spinning operation using forming tool	38	15	18	26	70	5	10	10	54	17	9	20
20. Ream holes with lathe	10	20	23	44	35	10	10	40	11	9	29	49
21. Recut threads on lathe	13	20	28	36	25	15	30	20	6	9	34	49
22. Rough cut and finish cut with lathe	5	15	5	72	5	0	10	75	9	0	0	89
23. Knurl parts with lathe	10	33	31	23	20	30	35	10	6	3	31	57
24. Secure tool holder, fixtures or attachments	5	10	15	67	5	0	30	55	11	0	6	80
25. Select and set speeds and feeds	8	10	5	74	5	0	15	70	6	0	3	89
26. Set up engine lathe	8	13	5	72	20	10	10	50	6	3	0	89
27. Set up turret lathe for operations	31	13	13	41	60	5	15	10	49	14	14	23
28. Tap threads with lathe	10	10	36	41	25	10	25	30	11	17	34	34
29. Set up tool post grinder	18	15	33	31	40	25	20	10	26	23	28	23
30. Perform grinding operation	15	18	33	28	40	25	20	10	31	17	29	20

APPENDIX A-4

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Supervisors N = 39				Machinists N = 20				Instructors N = 35			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
I. OPERATING MILLING MACHINES												
1. Align milling machine fixtures	8	18	28	44	10	15	40	25	11	11	20	57
2. Align milling machine attachments	5	18	36	38	30	10	30	25	11	0	26	63
3. Assemble completed mill work	18	8	28	44	30	15	25	20	14	14	34	37
4. Bore holes with milling machines	5	15	31	46	25	15	20	35	11	17	46	23
5. Bore to finish busing	10	15	23	49	40	5	20	30	20	26	29	23
6. Bore to remove bushings	23	20	18	36	50	15	10	20	31	23	34	9
7. Cut external keyway	13	15	15	54	25	15	20	30	6	14	31	46
8. Drill holes with milling machine	10	13	36	38	15	10	35	30	14	14	26	46
9. Duplicate on the profile milling machine	49	20	8	20	85	5	5	0	71	20	6	3
10. Inspect completed mill work	10	15	15	56	30	5	35	25	17	3	14	66
11. Mill an angle	8	13	23	54	15	15	30	30	8	9	34	49
12. Mill an external radius	13	18	28	38	45	15	30	0	26	23	37	14
13. Mill cylindrical work	18	18	26	36	55	15	20	5	34	11	23	31
14. Mill gears	31	26	26	15	55	20	15	0	11	29	40	20
15. Mill internal slots using slotter and attachments	31	23	33	10	60	30	5	0	49	31	14	6
16. Perform end milling	5	10	13	69	15	15	5	55	14	0	17	69
17. Perform flycutting operations	8	18	28	41	25	15	20	30	17	14	26	40
18. Perform form milling	15	28	26	28	55	10	20	10	17	20	40	20
19. Perform reaming operations	13	20	28	36	40	15	15	25	23	14	23	34
20. Perform cutting-off operations	20	23	28	26	45	25	20	5	20	37	23	17
21. Perform straddle milling operations on the horizontal mill	20	23	33	20	45	25	25	0	17	31	34	17
22. Select and set speeds and feeds for milling	10	5	13	69	15	5	30	40	6	0	14	77
23. Square up metal using dividing head	20	15	36	26	55	5	30	5	17	23	37	20
24. Square up metal using table vise	8	13	28	49	15	10	20	45	9	14	14	60

APPENDIX A-4

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Supervisors N = 39				Machinists N = 20				Instructors N = 35			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
J. OPERATING POWER SAWS												
1. Cut and weld bandsaw blades to insert for contour sawing	18	18	26	36	40	20	15	15	9	9	23	57
2. Measure material and cut off material with power hack saw	13	18	10	56	20	15	20	40	9	0	3	86
3. Determine type of material to be sawed	15	10	18	54	25	10	25	35	6	3	20	69
4. Remove and replace saw blades	8	8	23	59	10	15	30	35	6	6	11	74
5. Sawing with metal band saw to scribed lines	13	18	15	51	25	15	20	30	11	3	20	66
6. Select and set speeds and feeds for sawing operations	10	10	13	64	25	10	20	35	11	6	14	66
7. Select appropriate blades	13	8	18	59	15	15	35	25	9	6	23	60
K. OPERATING PRESSES												
1. Set up and punch materials with press	49	10	10	28	55	15	15	10	66	17	17	0
2. Select accessories and attachments for press work	33	15	13	33	55	5	25	10	54	14	14	17
3. Set up press and assemble parts with presses	33	10	20	31	35	20	25	10	34	29	17	20
4. Set up press and disassemble parts with presses	31	15	18	31	30	20	30	10	31	29	17	23
5. Straighten miscellaneous parts with presses	31	15	26	23	30	20	30	10	23	23	31	20
6. Set up, remove and replace parts with presses	28	13	26	28	45	10	30	10	23	11	43	20
L. OPERATING SHAPERS												
1. Align shaper attachments, workpiece and cutting tool	18	10	33	33	40	10	35	10	17	6	26	49
2. Select and set speeds and feeds of shapers	23	10	28	36	40	10	35	10	17	9	20	51
3. Select, shape and sharpen cutting tools for shaper operation	26	15	20	33	45	10	30	10	28	6	26	40

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APPENDIX A-4

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Supervisors N = 39				Machinists N = 20				Instructors N = 35			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
M. PERFORMING PRODUCTION MACHINIST LINE WORK												
1. Remove and install pins	36	13	18	31	55	25	10	5	37	11	26	26
2. Remove defective splines and replace with new splines	41	18	13	26	70	15	5	5	54	9	26	9
3. Remove frozen or seized parts	26	23	15	33	45	35	5	10	31	20	31	14
N. MAINTAINING MACHINES AND TOOLS												
1. Inspect and change drive pulleys or belts	15	20	31	31	20	45	10	15	9	23	40	26
2. Clean and store hand tools, cutters, fixtures, jigs or attachments	10	15	26	46	20	5	30	35	9	14	17	57
3. Install, level and fasten down machines	18	20	23	36	40	35	5	10	17	26	49	8
4. Remove machine parts	18	15	31	33	15	30	20	25	9	20	43	26
5. Replace and adjust machine parts	18	15	26	38	15	25	30	20	9	20	34	34
6. Inspect and remove, replace or adjust machine guards	18	18	28	33	20	20	25	25	14	17	34	31
7. Scrape and paint machines	26	31	15	26	70	5	15	5	17	46	23	11
8. Inspect and repair hand tools	18	23	18	38	25	15	35	20	6	11	43	37
9. Store grinding wheels	13	28	13	44	35	25	20	15	23	17	23	37
10. Store precision tools	13	20	18	46	20	5	15	50	11	9	23	57
11. Perform maintenance on lathe	18	13	26	41	35	15	15	25	6	9	29	54
12. Perform maintenance on milling machine	15	15	28	38	35	20	20	15	8	9	34	49
13. Perform maintenance on drill press	15	15	31	36	35	15	25	15	6	11	31	49
14. Perform maintenance on grinder	18	18	28	33	35	10	25	20	8	9	34	49
15. Perform maintenance on band saw	13	13	38	33	35	20	20	15	11	14	26	49
16. Select coolants, cutting oils or compounds for machining operation	15	15	38	28	20	15	20	35	17	6	20	54
17. Clean arbor presses	28	23	20	26	50	20	10	10	34	11	29	26
18. Lubricate arbor press	28	23	18	28	55	20	10	10	26	17	26	26
19. Clean hydraulic press	33	20	15	28	70	5	5	10	31	14	29	23
20. Lubricate hydraulic presses	31	15	20	31	75	0	5	10	43	11	26	20
21. Inspect arbor presses for safe operational condition	33	15	18	31	65	5	5	20	23	9	26	40

APPENDIX A-4

MACHINE SHOP

REVALIDATION SURVEY OF INCUMBENT WORKERS BY PRESENT POSITION - 1978
(Continued)

Tasks	Supervisors N = 39				Machinists N = 20				Instructors N = 35			
	1	2	3	4	1	2	3	4	1	2	3	4
	%	%	%	%	%	%	%	%	%	%	%	%
22. Inspect hydraulic press for safe operational condition	28	15	15	39	60	10	5	15	29	6	17	43
23. Perform maintenance on power hacksaw	28	13	28	28	50	10	10	20	17	11	26	43
24. Inspect work area for safe working environment	18	5	10	38	20	10	15	30	11	6	6	63
O. MAINTAINING SHOP FACILITIES AND WORK AREAS												
1. Dispose of scrap metal, chips or shavings and trash or waste materials	18	5	20	54	35	5	15	40	9	9	3	71
2. Perform custodial tasks	26	13	10	49	45	5	10	35	20	9	23	43
3. Clean and maintain work and adjacent work areas	13	13	23	49	35	15	15	30	14	9	17	57
4. Paint facilities	26	20	23	28	65	5	15	10	29	23	23	20
5. Sweep and clean shop facility	15	8	18	56	65	0	0	30	23	6	6	60
P. OPERATING NUMERICAL CONTROL N/C MACHINES												
1. Transfer drawing to tape	56	10	3	28	90	0	0	0	54	14	17	14
2. Turn with N/C machine	44	13	8	33	80	10	0	0	71	11	9	9
3. Mill with N/C machine	49	15	8	26	90	0	0	0	63	11	14	11
4. Drill with N/C machine	49	15	3	31	85	5	0	0	63	11	11	14
Q. OPERATING ELECTRICAL DISCHARGE MACHINE (EDM)												
1. Set up for EDM operation	54	23	13	8	85	0	5	5	51	17	20	11

APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5 Years	6-10 Years	Over 10 Years	Supervisor	Machinist	Instructor
	N = 48 %	N = 52 %	N = 5 %	N = 8 %	N = 80 %	N = 39 %	N = 20 %	N = 35 %
1. Files	100	98	100	100	100	97	100	100
2. Hammers	100	98	100	100	99	97	100	100
3. Wrenches	100	98	100	100	99	97	100	100
4. Screw Drivers	100	98	100	100	99	97	100	100
5. Center Punches	100	100	100	100	100	100	100	100
6. Pliers	96	98	80	87	99	97	90	100
7. Taps	100	100	100	100	100	100	100	100
8. Drills	100	100	100	100	100	100	100	100
9. Hacksaw	94	100	80	100	99	100	85	100
10. Countersink	96	100	80	100	100	100	90	100
11. Key Type Chucks	100	98	100	100	99	100	95	100
12. Calipers	100	98	100	87	100	100	100	100
13. Steel Tape	100	92	80	100	97	95	90	100
14. Reamers	98	100	100	100	100	100	95	100
15. Vises	98	100	80	100	100	100	95	100
16. Emery Cloth	100	100	100	100	100	100	100	100
17. Scale	100	100	100	100	100	100	100	100
18. Drill Press, Floor Type	100	98	100	100	99	97	100	100
19. Flycutter	87	98	80	100	96	97	85	94
20. Chisels	96	92	60	75	97	97	80	100
21. Chuck	100	100	100	100	100	100	100	100
22. Clamps	96	100	80	100	100	100	90	100
23. Hand Grinder	81	94	60	75	92	100	90	80
24. Center Drills	100	100	100	100	100	100	100	100
25. Boring Mill, Horizontal	50	52	60	62	51	61	55	37
26. Straight Edge	35	38	20	50	38	51	40	23
27. Form Cutter, Single Flute	58	85	40	87	76	85	45	71
28. Magnetic Chucks	67	94	60	62	87	85	55	91
29. Die Hooks	10	40	20	25	29	33	25	17
30. Angle Dresser	40	86	40	50	70	77	50	54

APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5	6-10	Over 10	Supervisor	Machinist	Instructor
	N = 48	N = 52	Years N = 5	Years N = 8	Years N = 80	N = 39	N = 20	N = 35
	%	%	%	%	%	%	%	%
31. T-Slot Cutters	79	77	40	75	82	85	60	77
32. Right Hand	29	38	40	37	35	38	35	23
33. Indexing Centers	69	67	40	62	72	77	55	69
34. Radius Dresser	44	81	40	62	65	85	50	40
35. Slab Cutters	71	81	40	75	81	80	60	83
36. Left Hand	23	29	40	12	26	23	30	26
37. Broaching Machines	40	44	20	25	46	61	25	31
38. Mechanical Dividing Head	75	88	40	75	90	87	50	94
39. Grinder, O D	69	83	80	87	76	80	70	71
40. Diamond Wheels	54	81	20	75	70	85	50	54
41. Horizontal Head	42	63	40	37	57	64	55	43
42. Key Slotter	52	61	60	75	57	72	40	60
43. Measuring Wire, Thread and Gear	58	77	20	75	72	77	45	66
44. Slab Mill	46	71	0	50	66	64	35	66
45. Planer Gage	54	73	20	50	69	74	35	63
46. Laps	25	77	0	37	59	69	30	40
47. Tilting Table	50	79	20	37	72	82	50	57
48. Milling Attachment	67	85	20	75	81	92	60	71
49. Level	92	92	60	87	95	95	80	94
50. Counterbore	87	96	80	87	94	97	80	91
51. Combination Square	100	98	100	100	99	100	100	97
52. Straight Edge	96	94	100	100	95	97	100	91
53. Scriber	100	94	100	100	97	97	100	97
54. Threading Dies	98	94	80	100	99	100	90	97
55. Feeler Gage	94	96	80	100	97	100	90	94
56. Grinding Wheels	98	96	80	100	99	100	95	97
57. Boring Bar Holder	96	94	100	100	96	97	90	97
58. Number and Lettering Stamps	98	96	100	100	97	100	100	94
59. Tool Holder	100	94	100	100	97	100	95	97
60. Clamps and Straps	89	96	80	87	96	100	85	94

APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5	6-10	Over 10	Supervisor	Machinist	Instructor
	N = 48	N = 52	Years N = 5	Years N = 8	Years N = 80	N = 39	N = 20	N = 35
	%	%	%	%	%	%	%	%
61. Protractor	94	96	60	100	99	100	85	97
62. Deburring Tools	83	94	80	100	90	100	80	83
63. Grinder, Bench	94	92	80	87	96	100	90	94
64. Dividers	96	94	60	100	99	100	85	97
65. Dial Indicator	100	96	100	100	99	100	100	97
66. Tool Post	96	92	80	75	97	100	80	97
67. Center	100	92	80	100	97	100	90	97
68. Dial Caliper	85	94	80	87	91	95	85	87
69. Depth Micrometer	92	96	60	100	97	100	85	94
70. Drill Press, Bench	81	90	60	87	87	92	80	83
71. Hold-Downs	92	90	60	87	95	97	75	94
72. Hand Reamer	87	92	40	87	95	97	70	94
73. Vernier Caliper	94	94	80	100	95	97	95	91
74. V Blocks	96	96	80	100	99	100	90	97
75. Thread Micrometer	62	71	40	87	69	77	45	71
76. Honing Head	29	50	40	37	42	64	30	23
77. Rotary Head	29	63	20	25	54	69	30	37
78. Universal Head	35	60	20	50	54	67	30	40
79. Filing Machine	29	58	40	37	47	67	30	29
80. Tubing Micrometer	35	44	40	37	42	61	30	26
81. Contour Dresser	31	52	20	37	47	61	40	26
82. Radius Turning Attachment	37	61	20	37	56	77	25	34
83. Facing Head	42	54	40	37	54	74	35	31
84. Taper Gage	60	65	40	75	66	79	40	63
85. Tool Shapes and Grinder	42	52	40	50	50	64	35	37
86. Gear Cutting Machine	29	29	0	37	32	38	10	34
87. Magnetic Parallels	21	65	20	50	47	56	35	37
88. Screw Feed Attachment	33	48	0	50	46	61	20	34
89. Cutter Grinding Attachment	40	67	20	62	60	77	20	49
90. High Speed Head	27	42	20	37	37	64	15	17

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APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5	6-10	Over 10	Supervisor	Machinist	Instructor
	N = 48	N = 52	Years N = 5	Years N = 8	Years N = 80	N = 39	N = 20	N = 35
	%	%	%	%	%	%	%	%
91. Inverted Tooth Cutters	25	35	0	25	34	44	10	26
92. Collapsible Die Head	17	54	20	37	40	59	15	23
93. Grinding Attachment	60	65	40	37	71	74	35	71
94. Lathe, Vertical Turret	40	61	60	50	54	74	40	37
95. Square Blocks	50	75	40	37	69	72	45	63
96. Honing Machine	23	60	20	50	45	61	25	29
97. Ring Gage, Plain	33	60	20	50	52	67	10	46
98. Snap Gage, Plain	46	58	60	50	55	67	25	54
99. Interlocking Cutters	27	46	40	37	40	54	20	31
100. Ball Bearing Parallels	6	27	0	0	21	18	20	14
101. Graduated Scale	94	94	80	100	95	97	95	91
102. Micrometer, External	98	94	100	100	96	97	100	94
103. Angle Plates	81	94	80	75	94	95	75	89
104. Electric Furnace	54	50	20	37	59	46	40	66
105. Tapered Sleeves	88	73	40	75	86	82	60	89
106. Fixtures	75	86	60	75	89	92	70	77
107. Boring Tool	96	94	100	100	96	100	90	94
108. End Mill	94	94	60	100	97	100	80	97
109. Screw and Tap Extractors	92	92	80	87	95	100	80	91
110. Flexible Scale	85	90	60	87	91	95	75	89
111. Telescoping Gage	94	87	40	87	96	92	80	94
112. Dil Stone	12	23	20	0	21	23	5	20
113. Radius Gage	87	96	100	87	94	97	80	94
114. Transfer Screws and Punches	62	73	40	50	72	87	60	49
115. Dog	87	90	60	87	94	92	75	94
116. Center Gage	96	92	80	100	97	95	90	97
117. Boring Head	73	94	80	75	87	100	65	80
118. Gas Hardening Furnace	31	31	40	37	31	31	15	40
119. Drift Pins	77	83	60	75	85	92	60	80
120. Collets	87	96	80	87	95	97	80	94

APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5 Years	6-10 Years	Over 10 Years	Supervisor	Machinist	Instructor
	N = 48 %	N = 52 %	N = 5 %	N = 8 %	N = 80 %	N = 39 %	N = 20 %	N = 35 %
121. Face Plate	87	94	60	62	97	97	70	97
122. Parallels	90	96	80	62	99	100	75	97
123. Drive Pin Punches	77	86	60	62	89	87	60	91
124. Grinder, Surface	90	92	60	75	97	95	75	97
125. Arbor	92	90	80	87	96	95	80	94
126. Carriage Stop	81	87	80	75	90	90	75	83
127. Tapping Head	60	86	80	75	74	97	65	51
128. Mitering Attachment	15	14	20	25	14	23	5	11
129. Grinder, Cylindrical	52	67	60	75	61	69	45	57
130. Indexing Unit	65	77	40	100	75	82	65	66
-156- 131. Horizontal Planer	33	40	20	37	40	56	20	29
132. Leaf Gage	15	36	20	37	27	36	10	26
133. Rip Fence	10	17	0	12	16	26	5	9
134. Grinder, I D	48	67	60	62	60	72	50	46
135. Cylindrical Grinding Attachment	42	65	60	37	59	77	25	46
136. Right Angle Head	25	52	20	50	42	64	15	26
137. Cat Head	33	27	0	50	31	41	15	29
138. Riser Block	33	60	20	37	52	72	30	29
139. Shaping Attachment	33	50	20	25	49	61	15	37
140. Shaper, Vertical	33	42	20	25	42	51	15	40
141. Jewelers Saw	10	21	0	0	19	20	15	14
142. Jig Borer, Vertical	23	36	20	25	32	46	15	23
143. Punch Form Grinding Fixture	2	13	0	0	9	10	5	9
144. Spring Making Attachment	19	38	0	25	34	38	5	31
145. Tracer	40	58	40	62	51	61	30	49

APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5 Years	6-10 Years	Over 10 Years	Supervisor	Machinist	Instructor
	N = 48	N = 52	N = 5	N = 8	N = 80	N = 39	N = 20	N = 35
	%	%	%	%	%	%	%	%
146. 30 Angle Guide	17	31	0	0	29	33	15	20
147. Grinder, Jig	23	35	40	37	29	41	25	20
148. Snap Gage, Thread	25	44	20	37	37	49	25	29
149. Drill Press, Sensitive	44	67	60	50	57	59	50	63
150. Microbore Bore and Tools	19	23	20	12	24	36	10	11
151. Quill Head	33	40	20	37	40	59	25	26
152. Indicator Square	23	33	0	12	32	46	25	11
153. Microscope	8	38	20	0	29	36	15	17
154. Tracer Attachment	42	58	20	62	52	64	30	46
155. Milling Cutters	90	96	80	100	95	100	80	94
156. Small Hole Gage	81	90	80	87	90	90	75	91
157. Micrometer, Internal	92	92	100	100	92	92	90	94
158. Bandsaw, Horizontal Cutoff	88	94	100	100	91	97	90	86
159. Diamond Dresser	87	90	80	87	92	90	80	94
160. Keyway Cutters	85	85	60	100	89	90	75	86
161. Steady Rest	94	92	60	100	97	97	80	97
162. Taper Attachment	96	90	80	100	97	95	90	97
163. Work Clamps	87	96	80	87	95	100	90	86
164. Height Setting Gage	62	84	60	62	79	90	55	71
165. Surface Plate	73	98	40	62	94	95	60	94
166. Lathe, Engine	98	96	100	100	100	100	95	97
167. Milling Machine, Horizontal	94	94	100	87	99	92	90	100
168. Set Up Blocks	77	85	80	75	86	92	70	77
169. Milling Machine, Vertical	92	94	80	100	97	95	85	97
170. Go-No Go Gage	52	77	40	50	70	72	50	63

APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5 Years	6-10 Years	Over 10 Years	Supervisor	Machinist	Instructor
	N = 48	N = 52	N = 5	N = 8	N = 80	N = 39	N = 20	N = 35
	%	%	%	%	%	%	%	%
171. Height Gage	75	92	80	75	90	92	70	86
172. Hydraulic Press	77	79	40	87	86	85	70	80
173. Surface Gage	83	98	60	87	95	97	80	91
174. Sleeves	92	81	60	87	94	87	75	97
175. Grinder, Carbide	67	77	60	100	74	90	55	63
176. Face Mill	65	83	80	62	80	85	45	80
177. Drill Press, Radial	79	85	60	75	85	92	65	83
178. Quick Change Chucks	60	73	60	75	69	82	50	63
179. Bandsaw, Contour	60	75	60	50	74	64	55	80
180. Bandsaw, Vertical Cutoff	56	73	60	75	67	77	50	60
181. Work Holding Jaws	56	86	80	75	76	85	70	60
182. Sweeping Tool	17	25	20	12	24	36	5	17
183. Flush Pin Gage	10	31	20	25	22	26	10	20
184. Diamond Charged Mandrels	8	11	20	12	8	10	20	6
185. Jig Borer, Horizontal	10	21	20	25	16	20	5	20
186. Milling Machine, Profile	19	40	40	25	32	38	25	26
187. Gooseneck Spring	15	19	0	25	17	20	10	20
188. Lapping Machine	12	46	0	50	31	44	23	15
189. Grinder, Centerless	17	31	40	25	22	33	20	14
190. Internal Spindle	23	31	40	12	30	44	15	20
191. Slotter	31	44	20	37	41	54	20	34
192. Lathe, Tracer	35	60	20	50	52	56	30	49
193. Duplicating Head	15	33	0	12	29	33	15	20
194. Automatic Screw Machine	10	21	20	12	17	26	10	11
195. Loupe	4	31	20	12	20	15	25	14
196. Standard Measuring Machine	0	15	0	0	10	13	5	3
197. Vacuum Chucks	6	21	0	25	15	26	10	6
198. Slot Grinder	4	17	20	0	12	18	10	6
199. Comparators, Mechanical	15	54	40	37	36	46	30	26
200. Optical Dividing Head	8	17	20	25	12	18	5	14

APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5 Years	6-10 Years	Over 10 Years	Supervisor	Machinist	Instructor
	N = 48	N = 52	N = 5	N = 8	N = 80	N = 39	N = 20	N = 35
	%	%	%	%	%	%	%	%
201. Shadowgraph	12	40	40	12	29	33	25	26
202. Jig Grinding Head	10	21	20	12	16	18	20	14
203. Rack Cutting Attachment	12	23	20	12	19	20	10	23
204. Tracer Attachment	29	38	40	50	34	44	25	31
205. Electrical Discharge Machine	25	54	60	50	40	36	25	54
206. Numerical Controlled Machine	27	52	20	62	40	46	20	43
207. Wheel Crushing Attachment	12	10	20	25	9	15	5	9
208. Optical Flats and Monochromatic Light	10	19	20	25	14	18	10	14
209. Arbor Press	72	88	80	62	86	87	65	83
210. Gage Blocks	62	92	20	50	86	90	50	80
211. Master Square	58	81	20	50	77	79	50	69
212. Screw Pitch Gage	83	87	60	100	89	85	70	94
213. Jig	58	67	60	62	66	74	55	57
214. Side Milling Cutters	73	90	80	62	87	92	55	89
215. Slitting Saw	68	81	60	62	84	77	60	86
216. Tool Holders	92	90	60	100	95	95	75	97
217. Shell Mill	73	88	60	75	86	87	65	86
218. Spot Facers	56	81	20	87	74	79	40	71
219. Jacks	73	85	60	87	84	85	70	77
220. Single Point Boring Tool	77	90	80	87	86	92	65	86
221. Hones	54	75	20	75	70	85	60	46
222. Screw Jack	67	90	60	75	84	87	60	80
223. Wiggler	73	81	20	87	85	85	60	80
224. Lathe, Turret	54	71	40	75	66	74	45	60
225. Tool Post Turret	77	81	60	100	77	74	70	80

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APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5	6-10	Over 10	Supervisor	Machinist	Instructor
	N = 48	N = 52	Years N = 5	Years N = 8	Years N = 80	N = 39	N = 20	N = 35
	%	%	%	%	%	%	%	%
226. Hermaphrodite Calipers	79	75	60	75	82	77	65	86
227. Tailstop Attachment	48	58	40	25	57	69	45	43
228. Tool Post Grinder	73	71	60	50	79	82	65	71
229. Dividing Head	71	81	40	62	86	82	50	86
230. Rotary Table	65	90	40	62	85	90	50	80
231. Lathe, Toolroom	67	86	40	62	81	87	70	69
232. Magnetic Blocks	27	67	0	50	54	59	25	46
233. Lathe, Bench	54	75	40	50	70	82	65	57
234. Grinder, Pedestal	73	90	60	75	90	87	60	91
235. Carbide Grinding Burrs	42	61	0	37	59	82	35	29
236. Auto Collimator	8	10	0	0	9	10	20	3
237. Edge Finder	40	86	40	87	66	72	55	60
238. Comparators, Electronic	12	48	0	50	34	38	15	31
239. Comparators, Air	10	17	0	12	16	23	5	11
240. Arc Welder	71	50	60	75	60	74	60	40
241. Gas Welder	58	54	60	50	59	77	45	40
242. Cherrying Head	12	15	0	25	12	15	15	11
243. Panel Saw-Push Button	4	6	0	0	5	10	5	0
244. Vacuum Form	12	7	20	25	7	13	5	11
245. Groove Micrometer	6	35	0	12	25	31	15	14
246. Profilometer	10	29	0	25	21	31	5	17
247. Gas Cutting	62	44	60	50	55	72	40	37
248. Arc Cutting	50	33	40	62	41	59	35	29
249. Taperer Attachment	58	61	40	87	61	72	55	51
250. Oxyacetylene Torch	68	61	60	75	65	77	70	43

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APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5 Years	6-10 Years	Over 10 Years	Supervisor	Machinist	Instructor
	N = 48 %	N = 52 %	N = 5 %	N = 8 %	N = 80 %	N = 39 %	N = 20 %	N = 35 %
251. Vemco Drafting Machine	15	13	20	12	14	20	5	11
252. Flexowriter (Type # Control Machine Prog)	21	38	0	50	30	41	15	29
253. N. C. Tape Splicer	17	29	0	50	24	33	10	20
254. Vice Grip	79	88	60	87	90	95	80	80
255. Turnamatic Lathe	15	15	0	12	15	18	0	23
256. Adjacent Parallels	27	35	40	37	30	49	20	20
257. Forklift	48	48	60	62	47	77	50	14
258. Band Saw Welder	69	81	20	62	81	82	55	77
259. Crankshaft Grinder	8	13	20	12	11	5	0	26
260. Surface Grinder Dry	52	81	60	62	71	77	45	66
261. Brake Drum Machine	10	13	0	0	15	13	0	20
262. Cylinder Boring Bar	21	25	20	25	25	26	20	26
263. Drill Grinding Attachment	54	69	0	87	66	77	45	57
264. Follower Steady Rest	71	85	20	87	85	85	55	86
265. Shaper, Horizontal	69	31	40	50	79	77	45	77
266. Sliding Protractor	46	52	0	12	60	64	30	43
267. Counterweight Feed	17	13	20	25	15	26	10	9
268. Welding Attachment	31	29	20	25	32	41	15	31
269. Trammel	58	69	20	75	69	61	50	71
270. Centers With Dividing Head	60	60	20	75	66	69	35	66
271. Form Cutter, Multiple Flute	40	56	20	62	52	61	30	46
272. Hydraulic Feed	31	50	40	50	42	61	25	31
273. Indexing Head	62	75	40	87	75	82	45	71
274. Plug Gage, Plain	35	71	60	50	59	69	30	51
275. Sine Bar	35	79	40	50	64	72	30	60

APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5	6-10	Over 10	Supervisor	Machinist	Instructor
	N = 48	N = 52	Years N = 5	Years N = 8	Years N = 80	N = 39	N = 20	N = 35
	%	%	%	%	%	%	%	%
276. Dressing Attachment	40	63	60	37	56	72	50	37
277. Threading Stop	35	63	20	25	56	61	40	46
278. Milling Machine, Universal	67	79	40	62	79	82	55	77
279. Line Boring Bars	31	50	20	25	46	54	30	34
280. Swivel Vise	75	85	60	75	86	87	65	83
281. Hardness Tester	33	71	40	50	57	61	25	63
282. Boring Mill, Vertical	33	48	20	62	42	59	30	26
283. Template Gage	37	58	20	50	52	74	35	31
284. Anvil Micrometer	31	58	40	25	51	49	40	43
285. Turret Tailstop	31	48	40	37	42	64	30	23
286. Spotting Tool	33	40	0	62	39	61	25	23
287. Angular Blocks	25	38	0	50	35	46	25	26
288. Drill Press, Gang	17	48	20	25	37	49	20	26
289. Grinder, Cutter	37	75	20	62	64	74	30	54
290. Crankshaft Straightener	2	8	0	12	5	5	0	9
291. Valve Facing Machine	6	10	0	0	10	8	0	14
292. Seat Facing Machine	2	15	0	12	10	13	0	11
293. T-Square	46	52	20	50	52	61	40	43
294. Gas Forge	8	8	0	0	10	13	0	9
295. Electric Forge Hammer	2	10	0	0	7	8	0	6
296. Electric Welding	52	40	40	50	47	61	45	29
297. Spade Drills	33	52	20	25	49	72	20	26
298. Hyperdemic Syringe	0	13	0	0	9	5	5	11
299. Heater Wire	4	10	0	0	9	15	0	3
300. Hand Router	6	29	0	0	21	33	10	9

APPENDIX A-5

MACHINE SHOP

REVALIDATION OF TOOLS AND EQUIPMENT
1978 (Continued)

Tools and Equipment	Location		Time in Career Field			Present Position		
	West Virginia	Pennsylvania	1-5 Years	6-10 Years	Over 10 Years	Supervisor	Machinist	Instructor
	N = 48 %	N = 52 %	N = 5 %	N = 8 %	N = 80 %	N = 39 %	N = 20 %	N = 35 %
301. Overhead Router	2	8	0	0	6	8	0	6
302. Table Saw	21	36	0	12	34	49	10	20
303. Radial Arm Saw	8	27	0	0	21	31	10	11
304. Panel Saw	6	13	0	0	12	15	15	3
305. Bench Sander	17	42	0	0	34	51	15	17
306. Engraving Cutter Grinder	6	15	0	12	12	15	5	11
307. Hand Drill	81	81	60	75	84	97	65	71
308. Belt Sander	46	71	40	50	61	82	45	43
309. Orbital Sander	12	31	20	12	24	36	15	14
310. Cut Off Wheel (Grinder)	37	71	40	50	57	77	35	46
311. Diamond Grinder	21	40	20	37	32	51	25	17
312. Cavitron (Ultrasonic Grinder)	0	2	0	0	1	3	0	0
313. Calculator	25	50	20	62	39	51	35	23
314. Dial Depth Micrometer	31	52	0	50	47	64	30	26
315. Numerical Control (N/C) Machine	29	52	0	75	41	43	20	49
316. Electrical Discharge Machine (EDM)	23	56	40	50	40	44	10	51

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APPENDIX B
ADDITIONAL TOOLS AND EQUIPMENT

APPENDIX B

MACHINE SHOP

ADDITIONAL TOOLS AND EQUIPMENT

The following items were added by respondents to the tools/
equipment list of the occupational inventory survey:

- | | |
|--|--|
| 1. Anvil | 37. Grinder, cylindrical |
| 2. Arbor, stub | 38. Grinder, dial-in |
| 3. Babbitt | 39. Grinder, drill, jobber |
| 4. Bender, pines radius | 40. Grinder, electrical,
chemical |
| 5. Blocks, angle, webber | 41. Grinder, micro-form |
| 6. Block, bench | 42. Grinder, thread |
| 7. Brake, sheet metal | |
| 8. Centerfinder, wiggler | 43. Hobber, gear |
| 9. Center, stub | 44. Holder, base, indicator,
magnetic |
| 10. Centers, N/C machinery | 45. Holder, rule |
| 11. Chuckers, automatic | 46. Holder, tool quick change |
| 12. Clamp, seat key | |
| 13. Comparator, Optical | 47. Indicator, last word |
| 14. Comparator, surface finish | 48. Indicator, speed |
| 15. Cutter, drilling, carbide | |
| 16. Demagnetizer | 49. Lathe, dial-in |
| 17. Die bolt | 50. Lathe, turret, 2nd operation |
| 18. Die, metric | |
| 19. Die, pipe | 51. Machine, drawing, ellipse
layout |
| 20. Dresser, wheel, magazine | 52. Machine, hot stamping |
| 21. Dresser, wheel, mechanical | 53. Machine, milling, dial-in |
| 22. Drill, carbide | 54. Machine, N/C drilling |
| 23. Drills, metric | 55. Machine, threading bolt |
| 24. Dye, layout | |
| 25. Equipment, heating, ultrasonic | 56. Mandrels, expanding |
| 26. Equipment, radiographic | 57. Micrometers, digital |
| 27. Equipment, welding, Heli-Arc | 58. Micrometer, inside, jaw-
type |
| 28. Extractor, screw | 59. Micrometer, metrics |
| | 60. Micrometer, thread |
| 29. Gauge, center | |
| 30. Gauge, combination depth and angle | 61. Miller, boring, portable |
| 31. Gauge, drill point | 62. Miller, cam |
| 32. Gauge, height, tubular | 63. Miller, rotary head |
| 33. Gauge, rule depth | 64. Nibbler |
| 34. Gauge, screw pitch | |
| 35. Gauge, wire, American standard | 65. Plate, Surface, Granite |
| 36. Gauge, taper | 66. Press, Punch, 15-ton |

ADDITIONAL TOOLS AND EQUIPMENT (Continued)

- | | |
|------------------------------------|--|
| 67. Protractor, bevel, universal | 86. Tools, knurling |
| 68. Puller | 87. Tools, radius turning
(concave, convex) |
| 69. Punch, hole | 88. Tools, throw away carbide |
| 70. Punch, transfer | 89. Tools, trepanning |
| 71. Rule, starrett, 18", 24" | 90. Torch, propane |
| 72. Sander, grinder, disc | 91. Viewers, film, x-ray |
| 73. Scope, centering | 92. Vise, grinding, toolmakers |
| 74. Scraper, bearing | 93. Vise, three-way |
| 75. Scraper, hand, electrical | 94. Wheel, grinding, aluminum
oxide |
| 76. Set, rivet | 95. Wheel, grinding, silicone
carbide |
| 77. Shear, sheet metal | 96. Welder, MIG |
| 78. Slager, gear | 97. Welder, TIG |
| 79. Snips, combination | 98. Welder, ultrasonic |
| 80. Table, tapping | |
| 81. Tap, carbide | |
| 82. Tap, metric | |
| 83. Tape, circumference | |
| 84. Tool post, lathe, quick change | |
| 85. Tools, engraving, hand | |

APPENDIX C
ADDITIONAL TASKS

APPENDIX C
MACHINE SHOP
ADDITIONAL TASKS

The following tasks were added by respondents to the task list of the occupational inventory survey:

A. PERFORMING SUPERVISORY FUNCTIONS

1. Attend production and supervisory meetings
2. Set shift schedules
3. Estimate time to complete work from drawings
4. Make working sketches
5. Hold progress reviews with employees
6. Instruct students in blueprint reading
7. Prepare students to draw proposed products
8. Teach safety procedures
9. Confer with designers on problem areas
10. Use independent judgment to make changes (that) save time or material
11. Calculate size of dies and mandrels
12. Check size of metals when solidified
13. Design die fixtures
14. Keep records of work completed
15. Schedule work in and out of shop
16. Supervise maintenance of shop steam
17. Line and repair of valves and slip joints
18. Instruct men to proper procedure
19. Complete management
20. Reminding co-workers to wear safety glasses and personal wear
21. Design machinery quote for processing in house
22. Estimating jobs
23. Sales calls to customers
24. Installation of machinery - all over U.S. and Canada
25. Supervise spare part inventory control
26. Supervise CRT operations
27. Stockroom supplies buyer
28. Ordering materials and supplies

B. PERFORMING MATHEMATICAL CALCULATIONS

1. Calculate change gearing for metric threading
2. Change gear ratios in reductions
3. Calculate and chase multiple lead screws
4. Figuring cards
5. Use comparator for checking tolerances

ADDITIONAL TASKS - MACHINE SHOP (Continued)

C. DESIGNING AND PLANNING MACHINE WORK

1. Design fixtures and tooling for new jobs
2. Select machine tools
3. Buy cutting tools
4. Disassemble broken and worn mechanisms and determine necessary repair
5. Ultrasonic testing
6. Write down notes on procedure of work being done, in case of coming across this job again
7. Have someone to double check over your work
8. Take time and just look over the drawing or blueprint

D. PERFORMING METALWORK OPERATIONS

1. Tight line measurement
2. Operate lathe
3. Operate milling machines
4. Operate drills
5. Operate surface grinder
6. Operate saws
7. Operate shapers
8. Have layout with surface indicator
9. Have checked layout with surface indicator
10. Fabricate sheets of stainless steel
11. Have used magnetic holding device
12. Measure with comparator

E. PERFORMING BENCH WORK

1. Teach students how to perform work with chisels
2. Ream holes with adjustable reamer
3. Press forming
4. Use chisels to perform design work
5. Use hand grinders (Dumore)
6. Use riffles (toolmakers)
7. Have keyed out keyways by hand
8. Condition material surface for layout
9. Apply layout fluid to work surface
10. Layout workpiece

F. OPERATING DRILL PRESSES

1. Hone with drill press
2. Back face
3. Use cutting solvent
4. Clean and lubricate drill press

ADDITIONAL TASKS - MACHINE SHOP (Continued)

G. OPERATING GRINDING MACHINES

1. Set up grinder and shape jointer blades
2. Run automatic drill sharpeners
3. Run automatic drill web thinners
4. Run gun drill sharpener
5. Sharpen taps
6. Sharpen reamers
7. Build precision grinders to customer specifications
8. Sharpen hobs and multiple toothed cutters
9. Use air grinder
10. Use grinder for tool and cutter re-sharpening
11. Set up work pieces in three (3) and four (4) jaw chucks
12. Use extreme safety on these operations
13. Form grind between centers
14. Grind taper between centers

H. OPERATING LATHES

1. Check threading operations for proper set up
2. Perform lathe operations between centers
3. Chase multiple lead threads
4. Cut square holes
5. Oil grooves
6. Regrind centers on the lathe
7. Grind chuck jaws
8. Repair chuck scroll
9. Make live center
10. Make tap holder
11. Set up tracer and trace work with template
12. Spring winding
13. Parting operations
14. Cut off on lathe
15. Select and use lathe workholding devices
16. Chuck work piece in four (4) jaw chuck
17. Chuck work piece in three (3) jaw chuck (or six (6) jaw)
18. Chuck work piece in drill chuck
19. Chuck work piece in collet chuck
20. Mount work on mandrel
21. Mount work on face plate
22. Select cutting tool and holder
23. Cut double lead threads
24. Cutting off work piece with parting tools
25. Precision form cutting

ADDITIONAL TASKS - MACHINE SHOP (Continued)

I. OPERATING MILLING MACHINES

1. Center drill precise hole locations
2. Hand shape curved surfaces
3. Mill worms and worm wheels and other short and long lead attachment work
4. Use of rotary table
5. How to read and interpret calculators, slide type
6. Set up and use rotary table
7. Set up and use angle vise with swivel base
8. Have milled internal radius
9. Clean and lubricate milling machine
10. Cut a spur gear
11. Cut a rack
12. Cut a bevel gear
13. Mill a helix
14. Mill a cam
15. Mill a dovetail
16. Cut scale gradations on round stock
17. Set up and cut anile using sine bar

J. OPERATING POWER SAWS

1. Instruct students in welding blades
2. Measure material and cut off material with horizontal bandsaw
3. Weld and anneal blades (bandsaw)
4. Adjust guides
5. Adjust feed
6. Deburred work piece cut off by hack and power saw
7. Fold bandsaw blades (storage)
8. Measure material and cut off material with horizontal band
9. Measure material and cut off material with vertical band
10. Power band filers

K. OPERATING PRESSES

1. Set up and form parts
2. Broach keyways
3. Bend material
4. Set up and use Porta-Power equipment
5. Fabricate stainless steel
6. Punch press operator

L. OPERATING SHAPERS

1. "We have no shapers, but we do have large slotters - vertical type."
2. Shape angles
3. Shape contours
4. Used for bending stainless steel

ADDITIONAL TASKS - MACHINE SHOP (Continued)

L. OPERATING SHAPERS (Continued)

5. Used for cutting internal keyway
6. Machine holding devices and parallels
7. Keyways internal and external
8. Clean, oil and adjust shaper
9. Adjust ram for length and position on stroke
10. Machine flat surface
11. Machine irregular surface
12. Machine keyway
13. Machine dovetail
14. Machine spline

M. PERFORMING PRODUCTION MACHINISTS LINE WORK

1. Remove broken studs and bolts
2. Remove broken taps
3. Machine metal inserts
4. Machine jigs for production work
5. Removal of broken taps and bolts

N. MAINTAINING MACHINES AND TOOLS

1. Perform maintenance on horizontal bandsaw
2. Perform maintenance on vertical bandsaw
3. Diagnose trouble in malfunctioning machine
4. Disassemble defective section of machine
5. Repair damaged parts of machine
6. Replace parts of machine
7. Test machine for performance after repair

O. MAINTAINING SHOP FACILITIES AND WORK AREAS

1. Keep an orderly tool box and/or cabinet

P. OPERATING NUMERICAL CONTROL N/C MACHINES

1. Perform all set up work
2. Do a lot of contouring
3. Cam work - prepare tape and program
4. Preset tools to precise size
5. Select correct feeds and speeds
6. Select correct grade of carbide
7. Manufacture holding devices
8. Use fixtures

ADDITIONAL TASKS - MACHINE SHOP (Continued)

Q. OPERATING ELECTRICAL DISCHARGE MACHINE (EDM)

1. Set up for EDM operation
2. Remove broken studs
3. Operate EDM to machine holes
4. Operate EDM to remove broken taps or other hardened parts
5. Select proper electrode material
6. Machine electrode to required shape
7. Select proper work holding device
8. Set up pulstaor and finish operations
9. Select proper electrode holder
10. Make electrodes
11. Drill holes in hard steel
12. Back burn punches
13. Burn internal screw threads
14. Burn forging dies